Caring for Alberta's Rural Landscape

Manure and Pasture Management for Horse Owners

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Written By:
Dr. Lori K. Warren and Christine Sweet

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AGRICULTURE, FOOD AND RURAL DEVELOPMENT

Acknowledgements

Contributors: Cathie Erichsen-Arychuk , Gordon Hutton, Janna Wowk

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Taking Care of Your Horses by Taking Care of Your Land

Alberta is home to more than 300,000 horses, representing 35 per cent of all the horses in Canada. As the popularity of horses continues to rise, so too does the number of small farms and acreages, and boarding stables. As a result, the amount of land dedicated to housing and feeding horses continues to increase.

The land management decisions you make affect your property, and they can also affect adjoining lands. By taking the initiative to become a responsible steward of the land, you will be a positive example in your community.

Whether you are boarding at a stable, own an acreage, or house horses on a farm or ranch, specific environmental land management practices can benefit your horse's health and well-being. The decisions you make for housing and pasturing your horses have a major effect on the land and your horse's productivity.

This guide has been compiled to provide you with options and references to help you manage the manure pile, maintain and improve your pastures, and provide a healthy and beautiful piece of land to live and ride on.

Take note of the tips and beneficial management practices detailed throughout this publication.

The Environmentally Friendly Horse

Our environment contains a variety of plants, animals and aquatic life. Each species has a unique role within the environment, and, as a result, each relies on the other for survival. Maintaining such biodiversity is essential for creating a healthy environment that is capable of sustaining all species that live within it. The more diverse the ecosystem, the better it is able to respond to changes or stresses, such as floods, drought, pests and disease.

You can help create and maintain a sustainable environment by modifying some of your land and horse management practices. The benefits of ecosystem management will be reflected in more productive pastures, clean water, fertile soils, and better overall health of your horses.

This chapter outlines and describes some key areas where your horse management practices may affect the environment and what you can do to minimize these effects.

Protect Your Water

Clean water is vital for the good health of you and your horses. Your land and horse management practices can influence the quality of water available not only to you, but also to your neighbours. Even if you do not live near a stream or lake, you can affect water quality.

Nature's Drain Pipe: The Watershed

Water initiates from springs, rainfall or snowmelt, and it runs downhill or underground until it eventually reaches the ocean. An area of land that catches rain and snow and then drains or seeps into surface waters (i.e. creeks, streams, rivers, lakes or wetlands) or groundwater is called a watershed.

Essentially, we all live in a watershed, which means everyone has an affect on water quality. As a landowner, you have a responsibility to maintain or improve the quality of the water that leaves your property.

Figure 1. Prevent water pollution by diverting runoff from rain and snowmelt around manure storage areas, corrals, riding rings or other areas manure accumulates.

Have you ever followed surface runoff as it flows across your land? Where does it go? Does it flow through your corrals, pasture or manure pile? Surface and groundwater can be contaminated if runoff is allowed to run through corrals, riding rings and other areas either where manure is not regularly removed or where manure is stored (Figure 1).

Tips for Maintaining Water Quality Downstream

- install rain gutters and roof runoff systems on barns and covered arenas
- create diversion berms to divert storm runoff around corrals and other confinement areas
- create catch basins for contaminated runoff

The Watershed Approach

Many Alberta communities are taking a "Watershed Approach" towards environmental land stewardship. This approach takes into consideration both ground and surface water flow within a particular watershed. If you are interested in learning more about your watershed, the publication *Getting to Know Your Local Watershed* (Agdex 576-8) is available from Alberta Agriculture.

Nature's Water Filter: Riparian Areas

Riparian refers to the land immediately surrounding waterways and other surface water. Riparian areas are defined as the zone of vegetation alongside creeks, streams, rivers, lakes and wetlands.

Riparian areas support high levels of biodiversity. The combination of deep rich soils, water and lush vegetation provides food, shelter and breeding grounds for many plants, animals and aquatic life. In fact, approximately 80 per cent of the province's wildlife use riparian areas for all or part of their life cycle.

In addition to housing a diverse population of plants and animals, healthy riparian areas provide the following benefits:

- buffer the negative effects of floods and winds by reducing soil erosion
- filter sediments and nutrients from runoff before they enter water sources
- riparian vegetation provides shading in the summer months and helps prevent ice damage in the winter
- reduce drought effects by holding and slowly releasing available water

While riparian areas are highly diverse and function to improve water flow and quality, they are also very sensitive and can easily be disturbed or destroyed by grazing animals (Figure 2). If you allow your horses to graze riparian areas, watch for signs that they are causing damage. Signs of damage to riparian areas include:

- reduction in number of saplings (i.e. young trees and shrubs)
- reduction in plant height resulting in vegetation cover that resembles a mowed lawn
- evidence of pugging (hoof tracks left in soft soil) and hummocking (soil that has been pushed up by pugging)

Riparian Management Tips

- Use alternative watering sources to keep your horses away from the water's edge and reduce trampling of the vegetation.
- Provide salt, supplemental feed and an alternative water source away from riparian areas. These practices will decrease the amount of time your horses spend in the riparian area and will reduce the risk of water contamination.
- Fence off access to riparian areas with either permanent or temporary fencing. This barrier creates a vegetative buffer zone between the water's edge and the pasture, which provides a natural filter for contaminated pasture runoff.
- If you allow your horses to graze riparian areas, turn them out for short periods to prevent overuse and trampling of the area. One option is to include the riparian area in your rotational grazing program. For more information on grazing management, refer to the chapter "Better Management of Your Horse's Pasture" in this manual.
- Avoid grazing riparian areas during the spring when the vegetation is more vulnerable to damage.
- For additional information on riparian area management, refer to the publication, "Caring for the Green Zone: Riparian Areas: A User's Guide to Health" (ISBN No. 0-7785-2305-5) available from the Public Lands Branch of Alberta Sustainable Resource Development.

Figure 2. Riparian areas are highly diverse and fragile. They can easily be damaged by grazing animals. Use riparian areas for short durations to reduce grazing impact.

Figure 3. Bare patches leave your pasture vulnerable to soil erosion and weeds.

Healthy Soil = Healthy Plants

Plants obtain the nutrients they need for growth from the soil. Therefore, to have a productive pasture, you need to maintain healthy soil.

Bare patches in your pasture and other areas that lack vegetative cover are vulnerable to soil erosion by wind or water (Figure 3). Erosion removes valuable topsoil, which is where most soil nutrients are found. Therefore, erosion can severely deplete soil fertility levels and starve pasture plants of nutrients needed for growth.

The health of your pasture can also be adversely affected by soil compaction. Soil will often become compacted in high traffic areas, such as near gates, along fencelines and on paths to and from water sources. There is also a risk of soil compaction in areas where horses loiter throughout the day, such as around feed bunks, water tanks and in shady areas. Overuse of such areas destroys plant cover and compacts the soil, reducing air and water infiltration as well as increasing the risk of soil erosion.

While the health of the soil is important to the health of a plant, the reverse is also true: a healthy plant is essential for a healthy soil. The roots of plants aerate and provide organic matter and nutrients to the soil. Roots also act to enhance soil structure and protect soil from erosion. Maintaining a healthy vegetative cover in your pasture will protect the soil from both erosion and compaction.

Tips for Preventing Soil Erosion and Compaction

Plant a Shelter Belt

A shelter belt is a row of trees or tall shrubs that act to capture blowing soil. Trees with a deep root system will bind soil aggregates better than shallow-rooted trees. Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration (PFRA), has a shelter belt program. For information on planting suitable shelter belts, contact your local PFRA office, or visit their website: www.agr.ca/pfra

Understand the Topography

Understand the landscape of your property and be aware of the drainage patterns on your land as well as on neighbouring lands. Protect areas of high runoff with vegetation cover. In some cases, it may be necessary to remove horses from an area entirely if the area is susceptible to water erosion.

Adjust Stocking Rates

Do not turn out more horses than your pasture can support (i.e. overstocking) and do not allow horses to graze plants down to the soil (i.e. overgrazing). Overstocking and overgrazing not only compact soil and cause erosion, they also severely reduce your pasture productivity.

Practice Rotational Grazing

Season-long grazing can reduce plant vigour and plant cover, resulting in a decline in pasture productivity. Cross-fence large pastures into smaller paddocks and rotate your horses between the paddocks. This type of grazing management gives each pasture a periodic rest from grazing and gives plants a chance to grow. For additional information on grazing systems, refer to the chapter "Better Management of Your Horse's Pasture" in this manual.

Alter Grazing Patterns

Change the location of your water source, feed bunks and salt blocks regularly to reduce the formation of dirt trails and to minimize the effect on areas where horses loiter.

Weed Invasions

Does your pasture appear to have more weeds than lush pasture grasses? A sure sign of stress to the land is the appearance of invasive weeds coupled with a reduction in the regrowth of desirable vegetation.

Weeds invade areas that have been denuded of vegetation because bare soil provides an ecological niche to exploit. The increase in available nutrients, water and sunlight as a result of a reduction in plant canopy cover provides an ideal environment for weeds to establish. Areas in your pasture that should be checked for weeds frequently include handling areas, watering sites, along fencelines and around winter feeding areas. Weeds also invade pastures that have been overgrazed.

You may not realize that you have invasive weeds. Some weed species produce attractive flowers that are pleasant to look at (Figures 4 and 5). However, weeds are considered undesirable plants with limited or no grazing value. Some weeds may even be harmful if eaten by your horse.

Figure 4. Purple loosestrife was introduced to Alberta as a garden ornamental because of its attractive rose-purple flowers. Purple loosestrife chokes out waterways and the native vegetation in riparian areas.

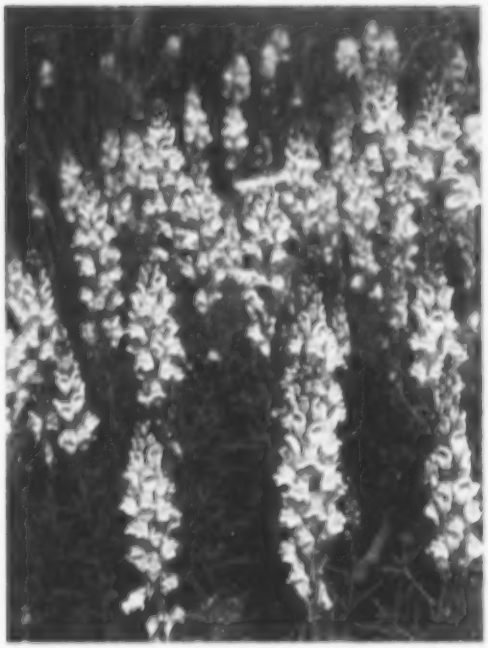


Figure 5. Yellow toadflax is an aggressive invader of pasture land. Toadflax has an extensive root system that makes it difficult and costly to erradicate.

Leaving weed infestations unchecked will decrease the overall productivity of your pasture, reducing the amount of nutritious forage available to your horse.

Weed eradication can also be expensive. Pastures may have to be taken out of production to allow time for an intense weed eradication program. Loss of a pasture means the added expense of supplying your horse with supplemental feed, which can be particularly hard on the pocketbook during times of drought or feed shortages. And depending on the weed species to be sprayed and the size of the affected area, herbicide cost must be factored in to the overall expense.

Early detection and early treatment is the best approach for preventing large scale weed infestations. For more information on weed identification and eradication, see the Alberta Agriculture publications *Weeds of the Prairies* (Agdex 640-4) and *Crop Protection* (Agdex 606-1).

Riding in the back-country

Trail riding in Alberta's beautiful and breathtaking countryside is a popular getaway for horse owners. However, many areas across the province are extremely sensitive to hoof tread, grazing and contamination from manure.

Whether you are at home or on holidays with your horses, it is important to be environmentally responsible. The following are tips to reduce your impact while enjoying the back-country:

- **camp in designated staging areas only**
- **take only weed-free feed for your horses**
- **take out what you bring in (i.e. all garbage, spare feed, manure, etc.)**
- **stay on the trails**
- **avoid riding near the edge of stream banks, because trail wear can make stream banks unstable and can lead to erosion during times of high runoff**

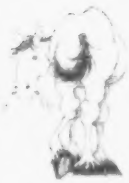
Be a Good Neighbour

As a horse owner, your land management decisions not only affect your property, but also the adjoining landscape. It is your responsibility, then, to keep updated on municipal bylaws to avoid an issue from arising among you, your neighbours and your local government.

Taking the initiative to become a good neighbour can prevent potential tension in the community. Beneficial environmental practices will decrease unwanted odours and pests and will reduce the spread of weed species. By demonstrating responsible agricultural practices with your land and horses, you can help everyone enjoy rural Alberta.

To maintain good neighbour relations:

- maintain healthy pastures and riparian areas
- control weed populations
- properly store and dispose of manure
- properly store and remove garbage



The Bottom Line

- Protect water quality by installing rain gutters on buildings, diverting storm runoff away from corrals and manure storage sites and limiting your horse's access to riparian areas.
- Prevent soil erosion and compaction by maintaining productive pastures and periodically rotating feeding and watering sites.
- Detect and treat weed invasions early before they spread and reduce pasture quality.
- Set an example in your community and in the province by practicing responsible land stewardship.

Manure Storage and Handling

On average, an 1100 pound (500 kg) horse will produce 31 pounds (14 kg) of feces and 2 to 3 gallons (8-11 litres) of urine per day, plus bedding. The amount of manure that can build up over one year from just one horse is substantial. If you are not careful with manure storage and handling, "Mount Manure" can become a serious management problem.

A poorly managed manure pile can harbour intestinal parasites, provide a breeding ground for flies and insects and produce objectionable odours. Runoff from improperly stored manure can quickly become a potential environmental contaminate, because it can carry nutrients, pathogens and organic particles into the water cycle via surface runoff or leach into groundwater. In addition to the health and environmental concerns listed above, "Mount Manure" is unsightly.

Regardless of the method of disposal, manure will have to be stored for some time, so proper manure storage facilities are important. Designing a storage facility and disposal plan are essential in any livestock operation. Once proper manure storage and handling facilities have been designed and constructed, they can be used yearly until the manure is disposed of.

Conquer Mount Manure by having an appropriate manure storage and disposal plan.

Step 1: Site Selection

Selecting an appropriate location for storing manure is an important first step in the design and construction process. Be aware that AOPA legislation provides both permanent and short term storage standards that apply to all livestock production, including horses. Anyone who handles and stores manure must consider setbacks, water table and flooding areas (Refer to AOPA Standards to see what applies to you).

Whether a formal storage facility is planned or a simple free-standing manure pile, several factors must be considered when determining the location of a storage site:

Protect water sources
In Alberta, manure cannot be stored within 330 feet (100 meters) of any spring or water well or within 100 feet (30 meters) of any open body of water. Contamination of surface water, groundwater and any common body of water must be avoided (Figure 6).

Topography
Manure storage facilities should be located where there is minimal runoff potential to reduce the risk of surface water contamination. Depressed areas, where water tends to pool, should also be avoided for the same reason.

Accessibility
Ensure there is ample room to manoeuvre machinery around the storage area.

Aesthetics
If possible, locate manure storage facilities out of sight of and downwind from public places and neighbouring residences.

The *Agricultural Operation Practices Act* (AOPA)

As of January 1, 2002, amendments to the *Agricultural Operation Practices Act* (AOPA) brought major changes to livestock management in the province. AOPA is Alberta's legislation governing new and expanding confined feeding operations (CFO's) and is administered and enforced by the Natural Resources Conservation Board. AOPA presents management standards for manure storage and handling, nutrient management and record keeping. For more information on AOPA and how it pertains to your operation, the *Agricultural Operation Practices Act* and associated Regulations are posted on Alberta Agriculture, Food and Rural Development's web site at **www.agric.gov.ab.ca/navigation/livestock/cfo/index.html**; click on Acts and Regulations under Categories. The Act and Regulations can also be printed from the web site. Questions can be directed to: **cfoinfo@gov.ab.ca**.

Figure 6. Unmanaged manure piles attract weeds and have the potential to contaminate surface or groundwater.

Step 2: Design and Layout

The design of any manure storage and handling facility will depend on the following factors:

1) **Volume of manure produced**
   The number of horses, the type of feed and the type and amount of bedding used will determine the amount of manure produced in each operation. The density of horse manure (urine + feces) is 63 lb/ft^3 (or 1 tonne/m^3). So, 51 pounds of manure would occupy 0.81 cubic feet or 22 litres. The addition of bedding can easily double or triple this volume. The volume may also vary depending on the management practices.

2) **Length of storage**
   Length of storage will depend on the intended use of the manure. For example, if the manure is to be used as a fertilizer, storage facilities must be able to store all the manure until the appropriate time of application, which can be up to six months or more. As a general rule, the longer the intended storage time, the larger the storage facility required.

   Large horse boarding operations (10 or more horses) with insufficient land base available for the use of all the waste produced would benefit from a permanent storage facility. Conversely, smaller operations (less then 10 horses) with sufficient land base available for manure application may store manure as a free-standing manure pile, rather than building a formal storage facility.

Example:
To determine the daily volume of waste produced:

a) Multiply 0.92 ft^3 (26 litres) times the number of horses on your farm. Remember to adjust upwards if bedding is included. (e.g. 1 part manure: 1 part bedding = 1.8 ft^3/horse/day.)

b) Then multiply the daily volume times the number of days the manure is to be stored.

c) Take the cubed root of the total storage volume required and work from there to determine suitable dimensions.

Figure 7. Calculation tip: count the number of wheelbarrow loads collected each day, and multiply by the estimated volume of each load to determine the volume of waste produced.

Table 1. Example bin size calculation for your operation.

Calculation	Imperial	Metric
a) **Waste volume calculated**	2.4 ft^3/horse/day x 6 horses = 14.4 ft^3/day	66 L/horse/day x 6 horses = 396 L/day or 0.40 m^3
b) **Storage Required**	14.4 ft^3/day x 120 days = 1728 ft^3	0.40 m^3/day x 120 days = 48 m^3
c) **Bin Size** Volume = length x height x width	1728 ft^3=17 ft x 17 ft x 6 ft	48 m^3 = 6 m x 6 m x 1.3 m

Step 3: Construction

Once the location of the manure storage area has been selected and a design determined, construction can begin. The type of material used in the construction is an important consideration. Choosing appropriate flooring material should not be overlooked, as proper flooring will prevent contaminants from leaching into groundwater. A concrete slab or well-compacted soils high in clay, but low in sand or gravel, are suitable flooring materials. Concrete, tightly fitted wood planks or cinder blocks can be used for constructing walls. Storage facilities that have walls will contain the manure pile and will facilitate the use of equipment necessary to handle the manure.

Constructing a roof or covering the manure pile with a tarpaulin or heavy plastic will reduce runoff and seepage from the storage area. Leaving the storage area open may be suitable in some low precipitation regions of Alberta, but this approach is not recommended. Covering the pile will reduce the risk of producing contaminated runoff. If, however, contaminated runoff becomes an issue:

- collect and contain the runoff by constructing a catch basin
- filter through a serpentine grassed waterway, grassed or treed filter strip
- disperse on cropland

Keep it together

Manure needs to be kept together to prevent contaminates from the manure from leaching into groundwater. Free-standing manure piles should be constructed on top of a concrete pad or heavy clay soil. In addition, consider covering the pile with a tarp and berming the storage area to divert clean runoff and to contain contaminated runoff.

Alberta Agriculture, Food and Rural Development (AAFRD) has several plans available for constructing suitable manure storage and handling facilities. For more information, please contact the Agtech Centre, 3000 College Drive South, Lethbridge, AB, T1K 1L6.

Manure Storage Options

- three-walled structure with roof or tarp cover (Figure 8)
- covered or enclosed truck bed or manure spreader (Figure 9)
- covered dumpsters
- covered, free-standing manure piles

Figure 9.

Figure 8. Three-walled structure contains the manure and can easily be covered with a tarp.

The Bottom Line

- Horses produce large amounts of manure.
- Site selection of a manure storage facility is important and must comply with the *Agricultural Operation Practices Act* (AOPA) standards and regulations.
- The design and construction of a manure storage facility depends on the volume of manure produced and the storage period.
- Storage should be considered a temporary solution for handling manure, because eventually, the manure needs to be disposed of.
- Manure storage facility construction must comply with the *Agricultural Operation Practices Act*.

Managing Horse Manure by Composting

Why Compost?

Many horse owners and urban horse facilities do not have access to enough land to make good use of raw manure by spreading. If you are one of these individuals, composting provides another option for managing horse manure.

Manure starts to decompose as soon as it hits the ground. Microorganisms in the soil, including bacteria, fungi, insects, worms and other creatures, break down the organic components of manure and bedding into smaller particles (Figure 10). In doing so, they recycle nutrients back into the soil, while releasing carbon dioxide, water and heat.

Although manure can decompose on its own, composting is a method of speeding up this natural process. The breakdown of manure and bedding occurs much more rapidly in the compost pile because the environment can be made ideal for the microbes to do their work. The end result of composting is a dark, crumbly, earthy-smelling product similar to potting soil.

Composting is of particular interest to horse owners because, if it is done properly, composting kills parasites eggs and larvae and destroys weed seeds in horse waste. Therefore, if the compost is later spread on pastures, the possibility of re-infection is reduced. Composting also reduces the odor of the manure and can decrease the size or volume of the pile by 50 per cent. Finished compost can be used to improve soil quality or serve as a mulch or growing media for plant nurseries, gardeners, mushroom growers and worm farms.

Figure 10. Soil microorganisms break down manure and bedding to form compost.

Recipe for Successful Composting

Like animals, the microorganisms responsible for composting need food, water and air to survive. The goal of composting is to provide the ideal environment and the proper balance of nutrients needed by the microorganisms to encourage their growth. Components of this "recipe" for successful composting include a number of key ingredients:

1) Availability of air

Microorganisms need air (oxygen) to be able to decompose manure properly. To provide space for air to move in and out of the pile, manure should be combined with bulkier materials, such as wood shavings or straw bedding mucked from a stall, or even lawn clippings, leaves or hay. Infusing air into the pile is also accomplished by mixing and turning the pile frequently or by inserting perforated PVC pipes into the pile.

Benefits of composting

- **Kills intestinal parasite eggs and larvae**
- **Destroys weed seeds**
- **Reduces flies by eliminating their breeding ground**
- **Reduces odor**
- **Reduces volume of manure**
- **Serves as an excellent soil amendment**
- **Produces an attractive product to use, give away, or sell to others.**

2) Moisture level

Microorganisms grow best with the moisture level at around 50 per cent. The average moisture content of horse manure is 70 per cent, but the manure may be closer to the ideal moisture content when it is combined with soiled bedding.

3) Particle size

Small particles decompose faster because they have more surface area for microbial activity. If you own a shredder or tub grinder, consider processing straw bedding, hay and other coarse materials before adding them to the compost pile.

4) Temperature

As microorganisms decompose manure and bedding, their body heat causes the temperature in the pile to rise. A hot pile decays much faster than a cold pile. Greater heat is necessary to kill weed seeds and parasites. Effective composting takes place around temperatures of 55 to 65°C (Figure 11).

Figure 11. Effective composting takes place at temperatures of 55 to 65°C (130 to 150°F).

5) Pile Size

The size of the pile influences whether the pile will hold heat. Small piles are usually colder and dry out faster. A pile of at least one cubic meter (3.5 x 3.5 x 3.5 feet) is big enough for year-round composting, even in the winter cold.

6) Nutrients

Microbes use carbon, nitrogen and other nutrients from materials added to the pile to support their own growth. Nitrogen is the main nutrient found in manure; carbon is the main element found in bedding material. The challenge is to ensure the proper proportions of carbon and nitrogen needed for successful composting.

The carbon-to-nitrogen ratio (C:N) of a material is an estimate of the relative amounts of these two elements. A ratio of about 30:1 is ideal for composting. Table 2 shows the approximate ratios for some materials commonly added to compost piles.

A mixture of one part manure with two parts bedding (by volume) usually gives a reasonable mix for rapid composting. However, the amount and type of bedding can alter the C:N ratio and influence the management needed for successful composting (refer to the sidebar "Bedding Tips.")

Table 2. Carbon to nitrogen ratios for manure and bedding materials.*

Material	C:N Ratio
Horse manure	20-40:1
Grass clippings	25:1
Horse manure with bedding	30-60:1
Grass hay	30-40:1
Straw	40-100:1
Paper	150-200:1
Wood chips, sawdust	200-500:1

* C:N ratios represent comparative weights. For example, 20 pounds of horse manure would contain 1 pound of nitrogen, while 500 pounds of sawdust would contain 1 pound of nitrogen. To estimate the C:N of a mixture, average the ratios of the individual materials. For example, a mixture of equal parts horse manure and straw might have a C:N of 30:1 ((20 + 40)/2 = 30).

Bedding Tips

- **Use less bedding...**
  Large quantities of bedding mixed with manure can slow the composting process by contributing excess carbon and upsetting the ideal C:N ratio. Be conservative with the amount of bedding in your stalls and remove only soiled material when cleaning. Installing rubber stall mats or rubber pavers can reduce the amount of bedding needed while maintaining the comfort of stalled horses.
- **If you use straw bedding...**
  The porous, spongy consistency of straw usually provides close to the right amount of free air space within the pile. However, the large particle size might delay the breakdown of straw. If a shredder or chipper is available, consider processing straw bedding before adding it to the compost pile. The addition of nitrogen to the compost pile may be necessary if large amounts of bedding are used.
- **If you use wood chips or sawdust bedding...**
  Wood bedding products contain very little nitrogen and a lot of carbon. Therefore, it may be necessary to add supplemental nitrogen to facilitate proper composting, particularly when large amounts of bedding are used. Wood chips are less likely to compact the pile, compared to finer sawdust. If you bed on sawdust, you may need to add other bulking materials to improve aeration. The advantage sawdust has over straw and wood chips is a smaller particle size. In fact, if managed properly, sawdust will compost faster than coarser bedding materials.

Locating Your Compost Pile

The first step in setting up a composting system is choosing a location. When choosing a location, consider the following:

1. **Select a fairly flat site**
2. **Avoid low lying areas**
   Pooled water, especially around manure and compost, will cause odour and fly problems and will increase the risk for runoff to contaminate water sources.
3. **Locate the compost pile away from groundwater and natural open bodies of water**
   In Alberta, compost sites cannot reside within 100 meters (330 feet) of any spring or well and must be located at least 30 meters (100 feet) from any open body of water, such as a stream, lake, river or slough. For more information on guidelines and regulations, refer to the chapter on "Manure Storage and Handling" in this manual.
4. **Locate the pile where water can be accessed if necessary**
   Water may be needed to maintain the appropriate moisture content of the compost pile and will need to be located conveniently in the unlikely event of a combustion fire.
5. **Be considerate of your neighbors**
   A well-managed pile will not have a foul odor or attract flies. Nonetheless, try to locate your bins out of view and downwind from neighbors.
6. **Allow room to maneuver equipment to build and turn the pile**

Choosing a Composting System

There are several ways to design an on-farm composting system, and no single one is appropriate for all sizes and types of equine facilities. You can tailor your composting system to meet your needs depending on how many horses you have, the space and equipment available and how intensively you plan to manage the pile.

Free-standing Compost Piles

Making compost does not necessarily require a special structure to house the materials. A simple, free-standing pile can be turned into an effective composting system and works well for one- or two-horse operations (Figure 12). The pile grows as manure and bedding are continually added to the top or sides of the mass. When the pile gets too big, additional piles can easily be created.

Frequent turning of the pile will hasten the composting process and help reduce parasites and weed seeds. However, many people prefer a less labor-intensive approach of building a new pile once or twice a year, turning the pile two or three times, then letting it take a year or so to mature. In this case, parasites and weed seeds may not be adequately destroyed.

Free-standing piles are usually the least costly option for composting because they do not require special structures or equipment. However, free-standing piles will require more space and careful consideration of location to prevent leaching and water contamination.

Windrow Composting

Manure and bedding can also be formed into long, horizontal piles, or windrows, for composting (Figure 13). The windrow pile is typically about 1.5 to 2 meters tall (5 to 6 feet) and 2 to 3 meters wide (6 to 10 feet). Materials are added at the end of the pile, allowing the pile to grow to any length.

These piles are generally turned with front-end loaders or specially equipped tractors, although they can also be turned by hand. Windrow composting works well for people with large herds and lots of space.

Figure 13. Composting manure in windrows.

Figure 12. Free-standing compost pile.

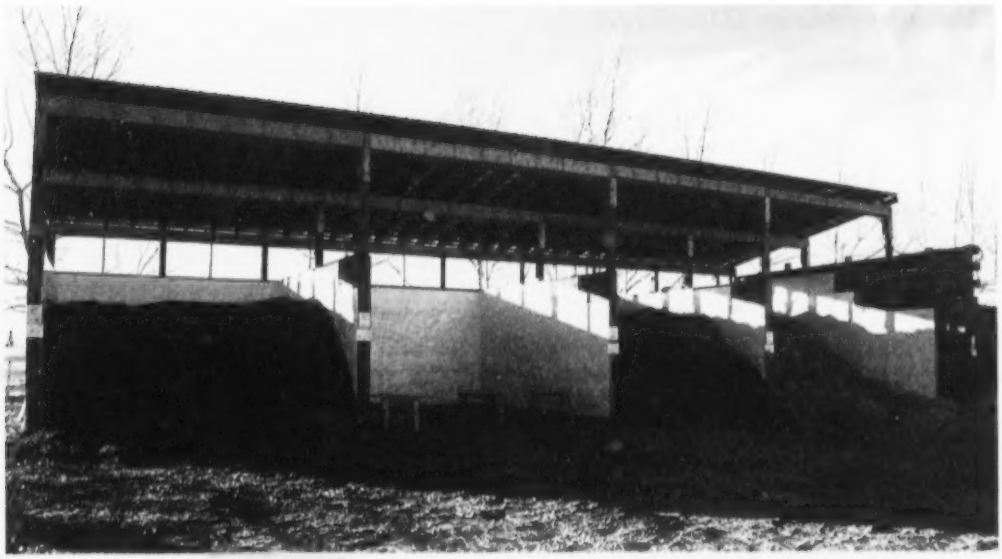


Figure 14. Multiple bin composting system.

Multiple Bin Composting System

Compared to stacking manure in a pile or windrow, decomposition is best and space is used more efficiently if the materials are placed in bins or some type of enclosure (Figure 14).

At least two bins are recommended for small operations that support just a few horses, or for those with no mechanical equipment. In this scenario, the first bin is filled to capacity and periodically turned and mixed with a shovel or pitchfork to promote composting. When the first bin is full, materials can be added to the second bin.

Larger facilities or those equipped with a small tractor or front-end loader, should consider building three or more bins. A series of bins allows the containment of waste at different stages of the composting process.

In a three-bin system, manure and bedding are piled into bin one until it is full. The material is then shifted into bin two for holding and composting. Meanwhile, bin one can be refilled. When bin one is full again, materials in bin two are shifted into bin three, and materials in bin one are shifted into bin two. Shifting material from one bin to the next serves as part of the turning and mixing process. Ideally, by the time bin one is full again, materials in bin three will be completely composted.

The size of the bins will be dictated by several factors:

- the amount of manure and bedding produced
- how long the materials will remain in the bin
- the equipment, if any, the bins will have to accommodate

Ideally, your bins should be large enough to accommodate all the waste materials accumulated for several months of composting. Refer to the sidebar "Determining Bin Size."

The materials needed for the construction of suitable bins will depend on the size of bins desired and whether they need to accommodate mechanical equipment. Bins constructed from 2 x 6" (untreated) boards and heavy-duty posts will hold up the best. Bins with a wooden floor with small spaces between boards that allow air to move from underneath the pile perform better than bins built directly on the ground. A concrete floor and strong walls are handy for larger bins that will accommodate mechanical equipment. A gravel access is convenient for loading or using a wheelbarrow to bring the manure to the heap.

Covering the compost bins with a permanent roof, plastic sheet or tarp is recommended. Protecting the pile from rainwater and snow will help you regulate the proper moisture level by preventing piles from becoming too wet in the winter or too dry in the summer. Covering will also prevent rain and snow melt from leaching contaminants from the pile and creating a pollution hazard.

Basic components of all composting systems:

1. **Adequate space for storage and composting.**
2. **A set of two or more bins or free-standing piles large enough to maintain elevated internal temperatures.**
3. **A mechanism for turning the piles or moving the compost from bin to bin, such as a pitchfork or a small front-end loader.**
4. **A water faucet or pump/water tank combo and a spray nozzle.**

Determining Bin Size

- **Calculate the amount of manure and bedding produced** (see Tables 3 and 4 for Example Calculations) An average 500 kg (1100 lb) horse produces 22 kg (0.81 ft^3) of manure plus bedding each day. If soiled bedding is combined with manure, the total volume generated each day can easily double (44 L or 1.6 ft^3) or triple (66 L or 2.4 ft^3). Alternatively, you can count the number of wheelbarrow loads generated from your operation each day and estimate the capacity of each load. Keep in mind these are just estimates and may increase or decrease depending on the volume of stall waste produced.
- **Determine how long the materials will remain in the bin**
  The use of only one or two bins usually means the materials will remain in the bins for longer periods (three to six months). When using three or more bins, each bin should provide enough space to house material generated for a two-month period. The volume of material in each bin will decrease over time as materials degrade, so subsequent bins may be slightly smaller if necessary.
- **Plan for extra bin space** if your operation will house more horses in the future.

Table 3.

Example Calculation: Two-Bin System for a Small Operation	
Number of horses	2
Volume of manure and bedding generated each day	2.4 ft^3/horse x 2 horses = 4.8 ft^3 (66 L/horse x 2 horses = 132 L or .13 m^3)
Amount of time materials will remain in each bin	4 months (120 days)
Size of each bin (2 bins)	4.8 ft^3/day x 120 days = 576 ft^3 576 ft^3 = 10 ft x 10 ft x 6 ft (.13 m^3/day x 120 days = 15.8 m^3) (15.8 m^3 = 3.5 x 3.5 x 1.3 m)

Table 4.

Example Calculation: Three-Bin System for a Large Operation	
Number of horses	12
Volume of manure and bedding generated each day	2.4 ft^3/horse x 12 horses = 28.8 ft^3 (66 L/horse x 12 horses = 792 L = .79 m^3)
Amount of time materials will remain in each bin	2 months (60 days)
Size of each bin (3 bins)	28.8 ft^3/day x 60 days = 1728 ft^3 1728 ft^3 = 17 ft x 17 ft x 6 ft (0.79 m^3/day x 60 days = 47.4 m^3) (47.4 m^3 = 5.6 x 5.6 .1.5 m)

Managing Your Compost Pile

Composting does demand some time and attention. Management of the compost pile can be kept simple or be quite sophisticated and should be customized to fit your specific situation and goals. Remember that some trial and error is an essential part of developing a successful composting system.

Building the Pile

A minimum pile size of one cubic meter (3.5 x 3.5 x 3.5 ft) is needed to achieve composting temperature. The pile can be bigger and will obviously be dictated by the type of composting system you choose and the space available. The minimum pile size may be created all at once or amassed over several days, and the pile allowed to grow from there.

Add manure and bedding directly to the compost pile as you clean your horse stalls. This is also the best time to add water if needed. Manure picked up from riding rings, arenas, trails and corrals can also be added directly to the pile. Avoid picking up too much dirt along with the manure, and keep all trash out of the pile.

What can you compost?

- **Manure mixed with bedding from stalls**
- **Manure picked up from pastures, corrals, arenas and trails**
- **Old, moldy or unwanted hay**
- **Grass clippings**
- **Leaves**
- **Household vegetable wastes**

Things to keep out of the compost pile:

- **Weeds**
- **Baling wire or twine**
- **Syringes and needles**
- **Soda cans and other trash**
- **Shoes, nails and other metals**
- **Plastic**
- **Cedar wood (resistant to decay)**

Monitoring the Temperature of the Pile

You should monitor the temperature of the pile weekly to ensure active composting is taking place. Effective composting temperatures range from 55 to 65°C. The center of a properly made heap should reach such temperatures within a week during the summer. In cooler seasons, it may take up to a month to reach effective composting temperatures.

To destroy parasites and weed seeds, temperatures of 55 to 65°C should be maintained for at least 21 days. Piles that are too cool (below 55°C) break down more slowly and do not kill parasites or weed seeds. Piles that are too hot (above 71°C) kill the composting microorganisms and result in an extremely foul-smelling pile.

A temperature probe can be used to eliminate the guesswork. Long-stemmed compost thermometers are available at most hardware and garden supply stores (Figure 11).

Turning and Mixing the Pile

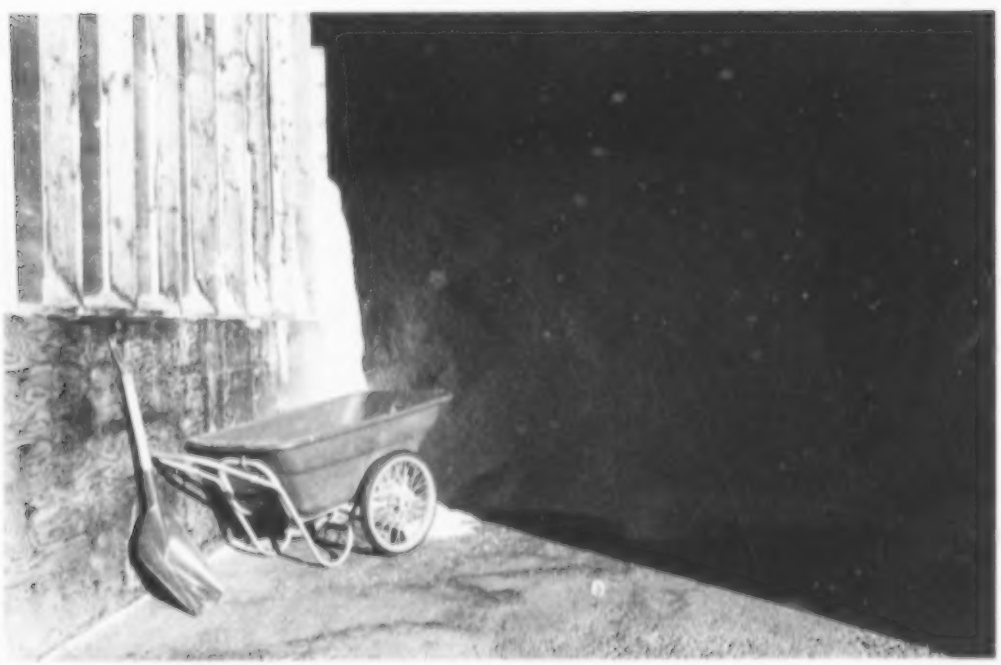
The most active site of composting takes place in the hotter center of the pile. Therefore, the pile needs to be turned and mixed to expose the material from the cooler, outer edges to the hot center. Turning not only helps aerate the pile, but it also ensures that weed seeds and parasites in the cooler sections are destroyed by bringing them into the center to "cook."

Depending on your composting system and the amount of manure generated, the pile can be mixed and turned by hand with a pitchfork or mechanically with a small front-end loader.

Frequent turning accelerates the composting process; the more it is turned, the faster the pile breaks down. Turning may be done on a weekly or monthly basis, or turning may be based on the measured temperature of the pile. If using temperature as a guide, you should turn piles when temperatures fall to 43°C or when they rise above 65°C.

Alternatively, your composting system might dictate your turning schedule. For example, if you have a multiple bin system, turning might occur as you shift the heap from one bin to the next.

Weather conditions might affect your turning schedule. The pile will take longer to reheat in the winter, so you may not want to turn the compost as often. Monitoring the temperature of the pile will be helpful in deciding when to turn the pile during the cold winter months in Alberta.



Winter composting tips:

- **Composting can still take place in the center of large piles in the winter.**
- **Composting will occur at a slower rate in the winter (four to five months, compared to two to three months in the summer). Make sure you have adequate storage space for stall waste.**
- **Keep piles large (at least one cubic meter) to maintain adequate heat for composting.**
- **Turn piles less frequently in the cold winter months. Turning piles during extremely cold weather may result in a slower rebound back to composting temperatures or a total shutdown of the whole composting process.**
- **If you are not already composting, winter is not the best time to begin. Instead, establish your composting system when the weather warms up in the spring.**

How long will it take to compost?

Depending on the amount of materials and how diligent the horse owner is in turning the compost pile, composting can take several months. A well-managed pile will break down the fastest—as quickly as 60 days—although the average time is 120 days. Piles that do not have the correct mix or are not maintained break down much more slowly, taking 6 to 12 months or more. In the winter, properly managed piles may require 4 to 5 months to compost.

As an alternative to frequent turning, PVC pipes can be inserted into the center of the compost pile like chimneys. Drilling several holes (1 cm or ½-inch in diameter) along each pipe (at approximately 15 cm or 6-inch intervals) will allow air to enter the pile passively.

Occasional turning of the pile may still be needed to get manure from the outside into the center, so the heat from the composting process can destroy parasites and weed seeds. It may take longer to compost a pile aerated by PVC pipes compared to a pile that is actively mixed on a regular basis.

Adding Water to the Pile

All materials in the pile must be moist, but not soaking wet. The moisture level can be gauged by squeezing a handful of compost. Compost that contains an adequate amount of moisture will feel like a freshly wrung out sponge. If water runs out of the pile or if you can squeeze water from a handful of compost, it is too wet. In this case, you will need to add straw, tree leaves, shredded bark or old hay to dry the pile. If the compost does not feel moist, you need to add water.

One of the biggest mistakes people make is putting a lot of water on the pile all at once, then ignoring the pile. Adding a little water each day is much better than letting the pile get dusty and dry, then trying to re-wet it back to the 50 per cent range. Consider watering your compost with a garden hose when you turn the pile. Or, an easy way to add water is just to hose down the manure in your wheelbarrow before you dump it into the pile.

The actual amount of water needed will vary substantially depending on the kind and amount of bedding used, the weather and if the compost is protected from rainfall. The more dry bedding included in the mixture or the warmer and dryer the weather, the more likely it is that you will have to add water. Make it a habit to check the moisture content when you turn the pile, or check more frequently during hot, windy summer days.

Can the compost pile catch fire?

Despite the high temperatures that develop in a compost pile, the pile will only ignite if the hot zone is next to a dry zone. So, it is important to keep the pile mixed and at the proper moisture level (50 per cent).

Adding Extra Nitrogen to the Pile

The more bedding you use, the more likely it is that you will need to add supplemental nitrogen. Bedding contributes primarily carbon to the compost pile. The use of too much bedding offsets the ideal C:N ratio and slows the composting process.

Because of the high C:N ratio of wood products, supplemental nitrogen may also need to be added to the pile if you use shavings or sawdust bedding.

Commercial fertilizers, such as urea, ammonium nitrate or another high-nitrogen fertilizer, can be added to the pile to provide supplemental nitrogen. Ideally, nitrogen should be sprinkled on each wheelbarrow load of manure dumped on the pile each day. Alternatively, nitrogen can be mixed into the pile when it is turned.

Table 5. Sources of supplemental nitrogen and amounts needed to provide 1.5 kg/tonne (or 3 lbs per ton).

Nitrogen source	% Nitrogen	Amount added per tonne (ton) of manure	Amount added per horse per day*
Urea	46%	3.25 kg (6.5 lbs)	75 g (2.5 oz)
Ammonium Nitrate	33%	4.5 kg (9.0 lbs)	100 g (3.25 oz)
Calcium Nitrate	15%	10 kg (20.0 lbs)	200 g (7 oz)

* Assumes 20 kg (45 lbs) of manure are produced per horse per day.

When adding supplemental nitrogen, a good rule of thumb is 1.5 kg of nitrogen per tonne of stall waste (3 lbs per ton). A ton of stall waste is equivalent to a pile approximately the size of an average washing machine. Table 5 lists several different sources of supplemental nitrogen and the amounts to add per tonne (or ton) of stall waste or the amount per horse per day.

Putting Compost to Use

After you have successfully produced compost, you need to think about what you will do with it. In many cases, compost is a more attractive product than raw manure, making it easier to give away or sell to others if you cannot use it yourself.

Figure 15. Harrowing horse manure compost distributes the nutrients more evenly across the field.

Properly prepared compost has many uses:

- **Soil Amendment**. Although compost contains nutrients, its greatest benefit is in improving soil characteristics. Composted horse manure can be used to increase the organic matter content and the water and nutrient-holding capacity of sandy and heavy clay soils.
- **Growth Media**. Finished compost can be used by plant nurseries as potting soil and is an excellent media for the production of mushrooms and fish worms.
- **Mulch**. Compost can be a valuable mulching material for garden and landscape plants. And if used as mulch, the compost need not be completely finished.
- **Slow-release Fertilizer**. When applied to lawns, cropland or pastures, finished compost can supply a modest amount of nutrients that will be released slowly over time. Since compost is already broken down, it does not deplete the soil of nitrogen needed by plants to grow. Nitrogen depletion can occur when uncomposted horse waste (or unfinished compost) are spread on fields. And because composting kills parasites and weed seeds, the risk of re-infection is reduced. Additional fertilization may be necessary to obtain acceptable growth yields when compost is applied as fertilizer.

If appiying finished compost to cropland (Figure 15) or pastures, it should be applied only at recommended rates and to plants and soils that can use the nutrients. For more information on testing your soil and compost, as well as guidelines for spreading compost on pastures and cropland, refer to the chapter "Managing Manure by Spreading on Cropland or Pasture" in this manual.

Is it Ready?

- **Finished Compost**
  When manure and bedding are completely degraded, they are termed "finished" compost. Finished compost will not heat up anymore and has an earthy smell and a crumbly soil-like texture. Properly produced compost will also be less likely to contain parasites and weed seeds. Because of this characteristic, finished compost can be safely used in gardens or applied to cropland or pastures.
- **Unfinished Compost**
  Decomposition will take place even if a compost pile is ignored after it has been built, but at a slower rate. Decay will be slower, cooler and less effective at killing weed seeds and pathogens. Manure and bedding that are not allowed to decompose fully are termed "unfinished" compost.

The Bottom Line

- Composting provides a viable option for managing horse manure.
- Properly prepared compost has many uses as a soil amendment, growing media, mulch or slow-release fertilizer.
- Compost may be a more attractive end product, compared to uncomposted stall waste, making it easier to give away or sell.
- Composting kills intestinal parasite eggs and larvae and also destroys weed seeds, reducing the risk of re-infection if compost is spread on pastures.
- On average, a well-managed pile can be composted in two to three months in the summer or four to six months in the winter.

Table 6. Compost troubleshooting

Symptom	Cause	Solution
Compost pile will not get hot	Pile may be too dry	Add water
	Pile may contain too much bedding (carbon)	Add fertilizer or manure to supply more nitrogen
	Pile may be too wet	Add more bulking materials; cover from rain
	Pile may be too small	Build a bigger pile
	Cold weather	Build a bigger pile
Compost has foul smell	Pile may be too wet	Add more bulking materials and turn pile
	Pile may need more air	Turn the pile more often
	Pile may contain a dead animal	Remove the carcass
Compost pile does not seem to be breaking down	Pile may be too dry	Add water
	Pile may be too small, not holding heat	Build a bigger pile
	Pile might not contain enough nitrogen	Add fertilizer or manure to supply more nitrogen

Managing Manure by Spreading on Cropland or Pasture

Using manure as a fertilizer by spreading on cropland or pasture may be one option for managing horse manure if you have sufficient land available (see sidebar, "Do You Have Enough Land?")

Manure contains nitrogen, phosphorus, potassium, sulfur and various micronutrients, which are all required for proper plant growth (Table 7). Horse manure is also high in organic matter, which can enhance soil quality by improving soil structure, increasing water and nutrient-holding capacity and reducing susceptibility to erosion.

Horse manure is an excellent fertilizer for pastures and field crops when applied in the *correct amount* and at the *optimum time* (Figure 16). When to apply the manure and how much to apply is depends on several factors:

- physical, chemical and biological characteristics of the soil
- composition of the manure
- the type of crop or pasture where the manure will be spread

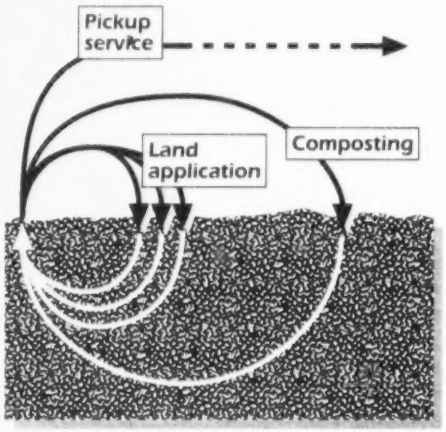


Figure 16. Three options to manage the manure on your farm.
Courtesy University of Minnesota Extension Service: www.extension.umn.edu

Table 7. Average composition of fresh manure (wet-weight basis)*

Type of waste	Nitrogen (as N)		Phosphorus (as P_2O_5)		Potassium (as K_2O)	
	%	lbs per ton (kg per tonne)	%	lbs per ton (kg per tonne)	%	lbs per ton (kg per tonne)
Manure	0.55	11.0 (5.5)	0.30	6.0 (3.0)	0.40	8.0 (4.0)
Manure and bedding**	0.56	13.2 (6.6)	0.23	4.6 (2.3)	0.68	13.6 (6.8)

* Composition will vary depending on the type of bedding used, the horse's feed and how the manure is stored.
** Composition of manure and bedding is based on 60% manure, 15% urine and 25% straw bedding.
Source: *Horse Handling Facilities* (1997), Alberta Agriculture, Food and Rural Development (Agdex 460/722-1).

Do you have enough land?

The amount of land needed to take advantage of the fertilizer value of manure depends on the type of crop or pasture to be grown, targeted yield and soil analyses . For example, the manure produced by one to two horses in one year would be suitable for meeting the nitrogen requirements of approximately one acre of pastureland. Over-application of manure will affect plant growth and increase the risk of water contamination from runoff.

The amount of land needed for manure application can be calculated based on the nutrient composition of the manure and the fertilizer recommendations for the specific crop. For crop-specific fertilizer recommendations, please refer to Alberta Agriculture's website (www.agric.gov.ab.ca) or the Alberta Agriculture publications: *Alberta Fertilizer Guide* (Agdex 541-1) and *Crop Nutrition and Fertilizer Requirements* (Agdex 540-1).

Manure anyone?

If you do not have the land base to make effective use of all the manure and stall waste your horses produce, a neighbor or local farmer may be interested in using the manure for fertilizer on their land. Even though you will not actually be spreading the manure, AOPA regulatation applies to anyone who uses or transfers more than 300 tonnes of manure annually (the amount produced by approximately 35 horses or more). You should keep records of who removes the manure from your farm and how much manure they remove.

Step 1: Sample Your Soil

To take full advantage of any fertilizer, including manure, you should first sample your soil and have it analyzed. A soil test provides the basis for deciding the amount of manure required to correct any physical, chemical or biological deficiency present in the soil.

Figure 17. Soil sampling.

You can either take the soil samples yourself (see "Soil Sampling Tips") or hire an agricultural consultant who specializes in soil sampling to collect samples for you (Figure 17). The soil must be sampled correctly to obtain useful lab results that will lead to appropriate manure application recommendations.

Soil samples can be tested for the following:

- pH (a measure of soil alkalinity or acidity)
- organic matter
- nitrate-nitrogen, phosphorus, potassium, calcium and magnesium
- micronutrients (zinc, copper, iron and manganese)
- electrical conductivity (a measure of total salts)
- texture (per cent sand, silt and clay)

At the very least, routine soil analysis should include extractable nitrogen, phosphorus and electrical conductivity. The determination of electrical conductivity is particularly important if the land base has a long history of manure application. Additional tests can be performed if soil fertility levels or specific nutrients are a concern.

Results from a soil test are typically in the form of nitrogen (N), phosphate (as P_2O_5), potassium (as K_2O) and lime (to correct soil acidity) and should include fertilizer recommendations.

Soil Sampling Tips

1. **Know your soils**
   Soil varies by topography (i.e. slope and aspect), the type of vegetation present, past land use, and the type and amount of fertilizer applied in recent years. As a result, the characteristics of the soil may vary greatly, even in the same field. To obtain the most accurate soil profile, a composite number of soil samples should be obtained from each distinct soil region within the field.
2. **The 20-to-30 Rule**
   You should obtain 20 to 30 samples from each different soil type within each field (i.e. collect one batch of soil samples from the hill tops and a separate batch of samples from the base of the hills. When you are collecting the samples, be sure you are collecting them from the same crop cover (i.e. sample the pasture field, and separately sample the hay field.) Samples can be collected using a stainless steel or plastic soil tube or auger, or a clean garden spade. Be careful not to use rusty tools, because the sample may become contaminated with iron.
3. **Sample to cultivation depth**
   Different nutrients are active within different layers of the soil. To obtain a complete nutrient profile, you should collect samples from at least three depths: 0 to 6 inches (0 to 15 cm); 6 to 12 inches (15 to 30 cm) and 12 to 24 inches (30 to 60 cm). You may want to consult with a local soil laboratory or fertilizer company before sampling.
4. **Mix similar samples in a plastic pail**
   Soil samples should be placed in clean plastic pails, according to soil type and sample depth, for mixing. Be sure to mix the soils thoroughly, crushing lumps in the process. Do not use galvanized steel or brass containers, because the sample may become contaminated with iron or zinc, respectively.
5. **Package, label and submit**
   Place approximately one pound (0.5 kg) of each composite soil mix in a clean plastic bag, label the bag, complete the appropriate paperwork and submit the sample to a soil testing laboratory (see "Finding a Laboratory"). A separate soil sample should be submitted for each soil type and depth.

Step 2: Sample The Manure

You also need to sample and analyze the manure you intend to spread on your cropland or pasture. By understanding what nutrients the soil needs and what nutrients are available in the manure, you will be better able to accurately match the manure application to the needs of your pasture plants or field crop.

You should obtain manure samples as close to the intended application time as possible. The composition of manure can change with storage, so analysis just before spreading will yield the most accurate composition of the manure to be applied. Refer to "Manure Sampling Tips" for a detailed outline on how to collect manure samples properly.

Manure samples should be tested for the following:

- total nitrogen (N)
- total phosphorus (P)
- total potassium (K)
- ammonium-nitrogen (NH_4^+-N)
- moisture content

Finding a laboratory

Local soil testing and manure testing laboratories can be found in the Yellow Pages of your phone book under "Soil Testing," "Analytical Laboratories" or "Environmental Products and Services."

Keep records

Keep accurate and up-to-date records of manure applications for future crop and pasture planning. Records should include:

- **all soil and manure test results**
- **amount of manure applied and at what time of year**
- **list of crop and pasture species grown in each field**
- **crop and pasture production in each field**
- **amount of manure sold or given away to others**

Manure Sampling Tips

1. **Obtain a representative sample**
   Collect manure samples from six to eight different locations throughout the manure stack, using a pitchfork or shovel. Manure should be collected from the center of the stack, as well as near the outside of the pile. If the outer layer of the stack has become dry and hard, remove the crusty surface and sample deeper into the stack.
2. **Thoroughly mix the manure samples**
   Once all the samples have been collected, place the manure on a clean surface for mixing. With a shovel continuously scoop the outside of the pile to the center of the pile to ensure thorough mixing of the samples. Chop the larger manure particles into smaller pieces with a pitchfork or shovel.
3. **Collect a minimum of three sub-samples**
   To collect samples for analysis, place a one-gallon resealable freezer bag, turned inside out, over one hand and grab a handful of manure. With your free hand, turn the freezer bag right side out over the sample. Seal the bag and place it in another freezer bag to prevent leaks. Repeat this process twice more to obtain three representative sub-samples. Properly label each bag and freeze immediately to minimize odors and prevent nutrient loss.
4. **The 24-Hour Rule**
   Manure samples should be sent to a laboratory for analysis as quickly as possible to avoid nutrient loss. Ideally, samples should be analyzed within 24 hours of collection.

Step 3: Calculating Manure Application Rates

Applying the correct amount of manure to your pasture or crop is very important. Over-application of manure can become a pollution hazard if runoff carries excessive nutrients to surface water or if the contaminants leach into ground water. On the other hand, applying an inadequate amount of manure could reduce crop yields or pasture productivity.

Appropriate manure application rates are calculated based on the following:

- nutrients needed by the plant for optimum growth
- nutrients already in the soil
- nutrients *available* in the manure

Unlike with chemical fertilizers, not all the nutrients in manure are available to plants during the season it is applied. Rather, approximately half the nutrients in manure are available for the first year's crop; the remaining nutrients become available in successive years as the organic matter is broken down by micro-organisms in the soil. This "slow release" of nutrients from the breakdown of manure provides fertilizer value over a longer time.

Large amounts of straw or wood bedding may also affect the nutrients available in manure. Bedding materials undergoing decay have a high demand for nitrogen and will compete with plants for the available nitrogen in manure. As a result, plant growth may be depressed unless the crop or pasture is supplemented with a commercial nitrogen fertilizer. Composting the manure before spreading is one way to improve the availability of nitrogen to growing crops (see the chapter "Managing Horse Manure by Composting" in this manual).

Also note that when manure is used to meet the nitrogen requirement of a crop, phosphorus and potassium will generally be over applied. It is important to monitor the soil, through soil testing, for nutrient build-up. One way to avoid over applying phosphorus and potassium is to meet the soil requirements for these nutrients with manure and then top off the nitrogen requirements with chemical fertilizer.

Specific fertilizer recommendations for crops commonly grown in Alberta can be found on the Alberta Agriculture website (www.agric.gov.ab.ca) or in the following Alberta Agriculture publications:

- *Alberta Fertilizer Guide* (Agdex 541-1)
- *Crop Nutrition and Fertilizer Requirements* (Agdex 540-1)

Step 4: Applying Manure to Land

Once you know the amount of manure to apply to your crop or pasture, you need to decide on the time and method of application.

Manure should not be spread on frozen or snow-covered ground. Because the nutrients in manure cannot be incorporated into frozen soil, there is the potential for water contamination by way of surface runoff during snowmelt. Up to one-third of fall and winter-applied nitrogen may be lost due to denitrification, volatilization, leaching and surface runoff during the spring thaw (Figure 18).

If spreading manure on pasture, apply during the growing season (May to September) when grasses are actively growing. Keep in mind that spreading fresh, uncomposted manure on pastures may carry the risk of re-infesting your horse with intestinal parasites (see "Pasture: to spread or not to spread").

Avoid spreading manure over the same area year after year without soil sampling. Over application of manure may adversely affect forage and crop yield, and an accumulation of excess nutrients is a potential water pollution hazard.

Manure is typically spread using a manure spreader (Figure 19). The alternative is quite labor intensive depending on how much manure needs to be spread. Spreading can be done by carrying the manure out to the field with wheelbarrow or truck and then dumping it. Regardless of how the manure is spread, it is important to harrow or cultivate soon after the manure is applied, to break up the clumps and spread the manure uniformly across the field.

If spreading manure on cropland, apply and incorporate the manure into the soil just before seeding. Some crops, such as alfalfa, may benefit from additional applications of manure throughout the growing season.

To avoid contaminating the water supply, manure should be spread at least 100 feet (30 meters) from any surface water or well.

If you do not have the land base that can benefit from the fertilizer value of manure, make arrangements for your manure to be used off your property. Additional chapters in this manual will provide you with alternatives for managing your manure if spreading is not an option.

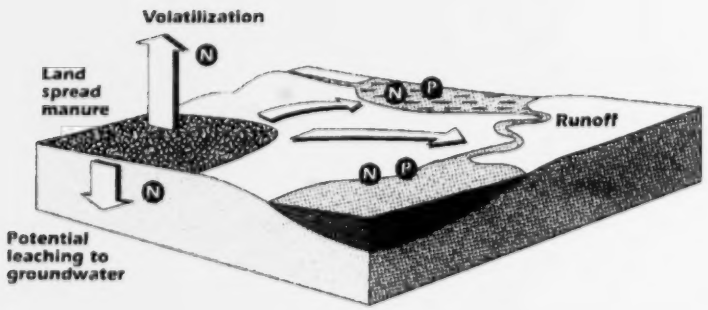


Figure 18. Denitrification and volatilization are chemical reactions that convert inorganic nitrogen ions (NO_3^- and NH_4^+, respectively) to nitrogen gases, which are lost to the atmosphere.
Courtesy University of Minnesota Extension Service: www.extension.umn.edu

The *Agriculture Operation Practices Act*

As of January 1, 2002, amendments to the *Agricultural Operation Practices Act* (AOPA) brought major changes to livestock management in the province. AOPA is Alberta's legislation governing new and expanding confined feeding operations (CFO's) and is administered and enforced by the Natural Resources Conservation Board (NRCB). AOPA also presents management standards for manure storage and handling, nutrient management and record keeping.

Figure 19. A custom spreader being used to spread large amounts of manure.

Pasture: To Spread or Not to Spread?

Even with a diligent deworming program, manure and stall waste can contain intestinal parasites, eggs and larvae that can live for years. Therefore, spreading raw manure and stall waste directly on a pasture carries the risk of spreading parasites.

Because composting kills parasite eggs and larvae, properly composting the manure before spreading can reduce the potential for re-contamination. For more information on composting, see the chapter "Managing Horse Manure by Composting" in this manual.

Alternatively, harrowing the manure in a pasture to break up manure clumps may allow the heat of the sun to penetrate the manure and kill the larvae. However, harrowing is less effective at destroying the parasite cycle. Harrowing should be done only during hot, dry weather and, ideally, horses should be removed from the pasture for two to four weeks after harrowing. Most importantly, if you spread fresh manure on your pastures, have your veterinarian perform routine fecal egg counts as part of your intestinal parasite control program.

Spreading Compost

Compost is essentially manure that has been actively managed to enhance the breakdown process. Because composted manure has undergone decomposition, nutrient levels in compost are somewhat different than in raw manure (Table 8).

While compost can provide some fertilizer value, it is best used as a soil amendment to improve the texture of the soil and the soil's nutrient level and water-holding capacity.

Spreading compost on cropland or pastures has several benefits over spreading manure:

- Compost does not clump like raw manure, so it spreads more uniformly.
- Compost contains less moisture than raw manure, resulting in a lighter load to haul and spread, making compost more affordable to spread over large areas.
- Proper composting destroys weed seeds and kills parasite eggs and larvae present in raw manure, thereby reducing the risk of re-infection.
- Compost carries less risk of depleting the soil, crops at all growth stages and pasture plants of nitrogen because the organic material in the manure has already been degraded more completely.

Table 8. Average composition of composted horse manure (on a wet-weight basis)*

Type of Compost	Nitrogen (as N)		Phosphorus (as P_2O_5)		Potassium (as K_2O)	
	%	lbs per ton (kg per tonne)	%	lbs per ton (kg per tonne)	%	lbs per ton (kg per tonne)
Manure with sawdust	0.48	9.6(4.8)	0.20	4.0(2.0)	0.25	5.0(2.5)
Manure with straw	0.63	12.6(6.3)	0.28	5.6(2.8)	1.03	20.6(10.3)

* Composition will vary depending on the type and amount of bedding used, any additional application of nitrogen and the stage of composting.
Source: Chaw, D. (2002) Passively Aerated Bunker System for Horse Manure: Final Report. Olds College Centre for Innovation, Composting Technology Centre.

Compost should be spread on pastures during the growing season (May to September) or incorporated into cropland before seeding.

Ideally, you should sample your compost and send it to a laboratory for analysis to gain a better understanding of how much compost to apply. Obtaining a representative sample of compost is similar to collecting a sample of manure for analysis (see "Manure Sampling Tips").

Manure and compost carry the risk of polluting water sources when runoff carries away nutrients and organic matter. Similar to manure handling methods, compost should not be spread on frozen ground or snow. In addition, compost should not be spread within 100 feet (30 meters) of surface water.

The Bottom Line

- Horse manure can be a valuable fertilizer if applied at the proper time in the proper amounts.
- Start by sampling your soil and manure to determine what nutrients your soil lacks and what level of manure to apply.
- To avoid contaminating the water supply, do not spread manure within 30 meters (100 feet) of surface water, and do not spread manure on frozen or snow-covered ground.
- If applying to cropland, spread and incorporate manure into the soil just before seeding.
- If applying to pasture, spread and harrow manure only during the growing season (May to September), when the grasses can use the nutrients.
- Spreading uncomposted manure on pasture carries the risk of contaminating your pastures with weed seeds and exposing your horse to larger intestinal parasite loads.

Marketing Manure

For some operations, more manure is produced annually than can be used. If you do not have the land base to maximize the benefits of the manure and stall waste your horses produce, make arrangements for the manure to be used off your property. Depending on the amount of manure produced, a number of options are available for alternative manure disposal.

Home Gardeners or Nurseries

Horse manure is a valuable fertilizer product for gardeners. Rose gardeners are particularly fond of the nutrient composition in horse manure. Marketing to rose gardeners and other backyard garden enthusiasts is a viable option for most horse owners.

Consider these factors when marketing manure to gardeners and nurseries:

- **Composted versus raw manure**
  Most gardeners tend to prefer composted manure, because it contains little or no weeds.
- **Product packaging**
  You may choose to package the product and sell it locally, or a less labor-intensive option is to have potential buyers shovel their own compost. If you choose the former, be sure to check with local garden centers to find out the price of packaged compost.

Donations welcome

If the idea of marketing your manure is a daunting one, relax, many crop farmers or home garden enthusiasts would be happy to take the manure pile. Having someone remove and dispose of the excess manure can be well worth the donation.

Thinking of burning?

Burning manure is not an appropriate management practice for the following reasons:

- **potential fire hazard**
- **valuable nutrients are lost**
- **smoke production results in unnecessary air pollution**

Mushroom Farms

Mushroom farms are another viable marketing option; however, these operations require large quantities and a dependable supply. If you are interested in this option, but do not have a large, dependable supply, consider forming agreements with neighbors to store their straw-bedded horse manure for a one-stop pick-up by the mushroom farm. This approach has the potential to be a workable and profitable community solution. It is important to note that mushroom growers are also quite particular about the quality of the product; they want manure mixed with straw bedding only and with no horsehair or garbage.

Commercial Users

Professional landscapers, organic farmers and land reclamation companies are also viable marketing options. In fact, many cattle feedlots have formed agreements with these types of companies to remove their composted manure. You may choose to enter into one of these agreements on your own or sell the manure to a feedlot that already has a contract. If you choose the former, remember that the compost is sold by the ton, and the company is responsible for loading and removing the compost.

Keep Accurate Records

Regardless of where the manure is marketed, it is important to keep accurate records. For instance, record the name and address of the person or company the manure is sold to, the date on which the manure was sold and the volume of manure sold. It is also important to know where the manure is going and what it is being used for.

The Bottom Line

- Manure is a marketable product.
- Keep accurate and up-to-date records of your sales.

Better Management of Your Horse's Pasture

A well maintained pasture can provide fresh air and exercise for your horse, and it can also supply a significant part of the horse's nutritional needs. If managed properly, even a small pasture can greatly decrease feeding costs, stable cleaning and other management chores, and it can greatly increase the horse's enjoyment of life.

All too often, horse pastures suffer from neglect. Pastures commonly house more horses than they can support, resulting in bare ground and weed infestations. Not only do these abused pastures fail to provide nutritious forage for your horse, the bare spots can be churned to dust and mud that present health risks such as respiratory disease, sand colic and thrush.

Mismanaged pastures also contribute greatly to degradation of the environment through erosion and water pollution from contaminated runoff. And, at the very least, overused pastures present an eyesore to your neighbors.

Environmental land management can be challenging when a number of horses are concentrated on a small parcel of land, such as on acreages. Where several acreages are situated near one another and near urban areas, maintaining good neighbour relations becomes critical. Suitable management of your pastures is a way to improve the appearance and productivity of your land and to prevent neighbour complaints.

Successful pasture management is not complicated, but it means horse owners must become much more aware of the quality and condition of their pastures. This chapter describes how to improve existing pastures and suggests strategies for getting the most potential out of pastures for your horses.

What's Growing in Your Pasture?

Effective pasture management requires an understanding of the forage species that *should* grow in your horse's pasture. Furthermore, gaining an appreciation of how pasture plants grow and develop, and how grazing and repeated trampling by hooves may affect the pasture, will help you make sound management decisions.

Grazing Alfalfa

Horses can be grazed on alfalfa pasture. Alfalfa is a legume and is higher in protein and slightly higher in energy than grass. In the spring, all grasses and legumes are lush and less mature. The less mature the stand, the higher in energy and protein. Introduce your horses to alfalfa pasture gradually, just as you would introduce them to a fresh, spring grass pasture.

Advantages of grass-legume pasture mixes

- **Mixing of grass and legume species provides a better level of nutrition for grazing horses because legumes provide more protein, energy (calories), calcium and vitamins than do grasses.**
- **The ability of legumes to "fix" nitrogen in the soil may reduce the amount of nitrogen fertilizer needed in the pasture. If legumes make up 40 per cent of the pasture, nitrogen fertilizer is not usually needed.**
- **Grasses and legumes have differing levels of production throughout the growing season, providing a steadier production of forage over the entire grazing season than an all-grass pasture.**
- **A balance of 40-60 per cent grasses and 40-60 per cent legumes is ideal for horse pastures.**

Growing up Tall

Like horses, plants go through several growth stages. Being able to recognize these different stages of plant growth is essential for making decisions on when and how long your horses can effectively graze the pasture.

Pasture plants have three distinct growth stages (Figure 20):

1) vegetative

2) elongation

3) reproductive

The "vegetative growth period" is the development of the leaves. This is a vulnerable stage for the forages and occurs in the spring as well as during the regrowth from grazing or mowing. Pasture plants use their leaves to gather solar energy from the sun, which they use to manufacture food, grow and reproduce. Avoid grazing during this vulnerable stage, so the plants have a "head start" for a longer and healthy growing season.

Once the plant develops enough leaves and stores enough energy, it enters the second growth stage, elongation. Elongation is the stage when the stem grows taller, but the number of leaves remains relatively the same.

Pasture plants are best grazed when they enter the elongation phase. The elongation phase both optimizes the nutritional quality of the pasture plant and ensures the plants will survive the grazing by your horse.

The final, reproductive stage is the period when the seedhead or flower develops, and pollination occurs. Once the seedhead or flower develops, all new growth ceases. Horses prefer to bypass grasses that are this mature and search for grasses in the two earlier phases.

The nutritional quality of pasture forage also varies depending on the plant's stage of growth. As a plant matures from the vegetative to reproductive stage, the fibre content increases and the nutritional value for horses decreases.

Although vegetative plants are the most nutritious, they are also the most fragile and susceptible to damage by grazing or trampling. Plants require some leaf area to support their own growth. Without these leaves, they have to rely on the limited energy stores in their roots for survival. Allowing your horse to graze off too much of the leaf area (termed "overgrazing") will slow the regrowth of the plant and possibly damage the root system. The plant could eventually die if overgrazing continues.

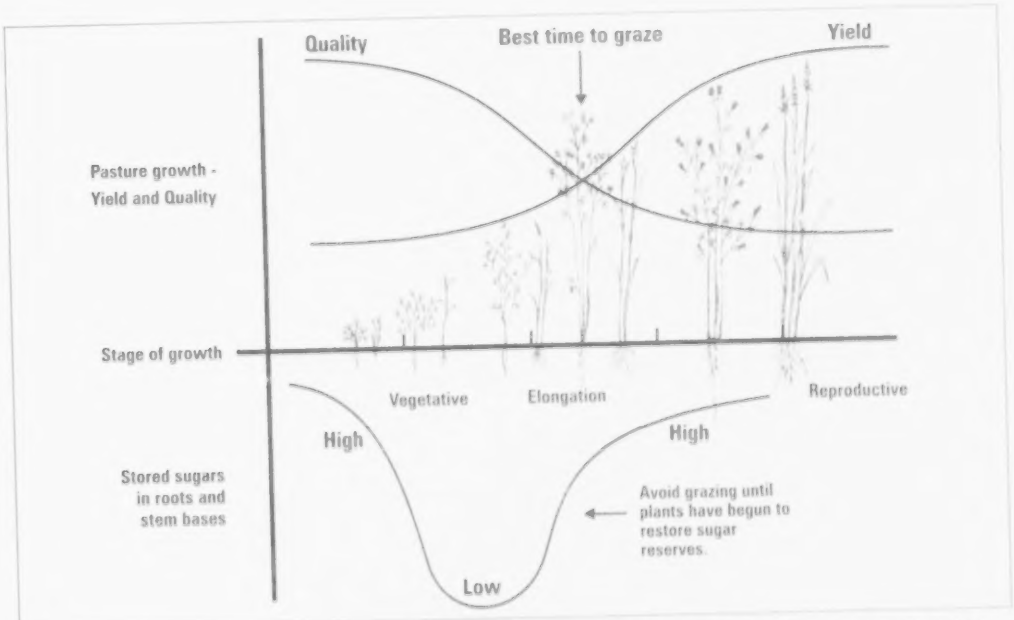


Figure 20. Grazing should take place when pasture plants are in the elongation stage of growth, before legumes flower and grasses produce seedheads. Grazing during the elongation stage optimizes the nutritional quality of the forage and the total pasture yield, while leaving enough food stores in the roots for pasture plants to regrow.

Selecting Plant Species for Horse Pastures in Alberta

Different pasture forages exhibit different growth characteristics, which you can take advantage of when designing a new pasture or improving an existing pasture. Ideally, you should select from forage species that possess the following characteristics:

- adapted to your local climate and soil
- adapted to the style of grazing management you will use
- provides a uniform amount of forage throughout the grazing season

There are two main types of forages: grasses and legumes. The primary difference between the two forages is that legumes have a mutually advantageous relationship with soil bacteria that enables them to utilize nitrogen from the air to make plant protein. Grasses do not have this ability and can only obtain nitrogen from the soil. As a result, legumes, particularly their leaves, are much higher in protein than grasses.

Common cool-season grasses in Alberta include meadow and smooth brome grasses, timothy, orchardgrass, creeping red fescue, and intermediate and crested wheatgrasses. Some grasses are bunch grasses, growing from a crown or above ground stem. Others are sod-forming grasses that spread by horizontal underground stems (rhizomes). Popular legumes include alfalfa, white clover, red clover and bird's-foot trefoil.

Grasses and legumes are complementary. Cool-season grasses have the greatest growth in the early spring and again in late summer or early fall, whereas legumes remain productive during the hotter summer months. The varying growth patterns of grasses and legumes provide more uniform grazing throughout the growing season. For example, when brome grass goes dormant under the stress of the hot, dry summer, alfalfa will produce good grazing; then, the roles reverse in the fall.

Ideally, a pasture should contain at least one species of grass and one legume. Single species pastures carry a higher risk of damage due to disease or drought and are less flexible in season-long grazing management systems. There is little advantage to including more than three or four grasses and legumes in the mixture. Plants are competitive creatures, and the most aggressive species in the mix may eventually crowd out the others.

Alberta has a wide range of climates and soil types. As a result, forage species selected for a pasture in one area of the province may differ from species adapted for another location. Even on the same property, different species may need to be chosen for each pasture, depending on the drainage, soil type and grazing pressure each area will receive.

Figure 21 shows a map of Alberta with recommended species mixtures for horse pastures in each region. For more information on specific forage species, refer to Alberta Agriculture's *Alberta Forage Manual* (Agdex 120/20-4).

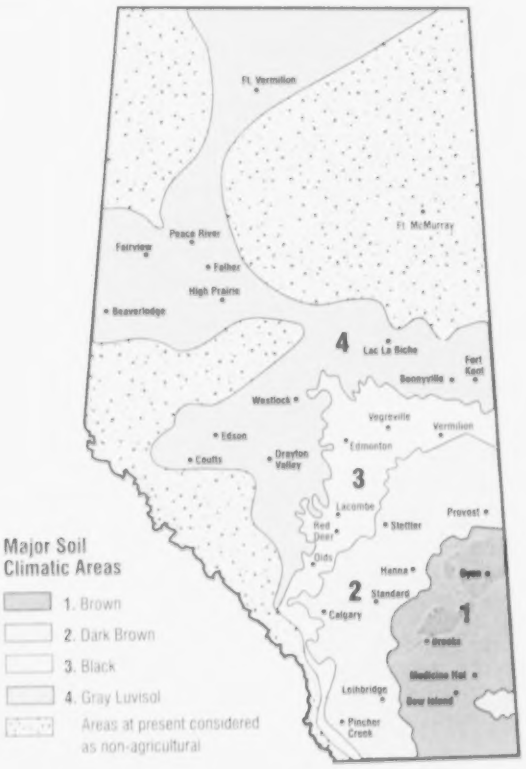


Figure 21. Grass and legume forage species suitable for horse pastures in different regions of Alberta. Ideally, horse pastures should contain at least one legume species and one or two grass species.

Suitable forage species for each area

Area 1 – Brown soil zone

Legumes:
- **Alfalfa**

Grasses:
- **Russian wild rye**
- **Crested wheatgrass**

Area 2 – Dark Brown soil zone

Legumes:
- **Alfalfa**

Grasses:
- **Meadow brome grass**
- **Smooth brome grass**
- **Intermediate wheatgrass**

Area 3 – Black soil zone

Legumes:
- **Alfalfa**

Grasses:
- **Meadow brome grass**
- **Smooth brome grass**
- **Timothy**
- **Creeping red fescue**

Area 4 – Gray luvisol soil zone

Legumes:
- **Alfalfa**
- **Red clover**

Grasses:
- **Meadow brome grass**
- **Smooth brome grass**
- **Timothy**
- **Creeping red fescue**

Withstanding high traffic

The areas around gates, water troughs, feed bunks and along the fence lines of adjoining pastures tend to get a lot of hoof traffic. Maintaining grass cover in these areas can be challenging. Start by selecting species that are more tolerant of repeated tread by hooves. Sod-forming grasses such as Kentucky blue grass, creeping red fescue and smooth brome are examples of grasses that would both provide ground cover and minimize soil disturbance.

Forage Species to Avoid

Although most forages can be grazed by horses, a couple of species may be harmful and should be avoided in a pasture mix for horses.

Alsike clover (*Trifolium hybridum*)

Alsike clover has been associated with the occurrence of photo-sensitization (over-sensitive to sunlight) and/or liver damage in horses. Unfortunately, the amount of alsike clover needed to cause harm is unknown, and some horses are thought to be more sensitive than others.

Affected horses may or may not show signs of photo-sensitization (sun-burned appearance of light-skinned areas, usually on the face, muzzle and legs). Similarly, blood tests may or may not show disruption of normal liver function.

See "Which Clover is it?" for help on distinguishing Alsike clover from red and white clovers.

Endophyte-infected Tall Fescue (*Festuca arundinacea*)

Older varieties of tall fescue may be infested with an endophyte (a fungus that lives inside the plant) that can be harmful to pregnant mares. The endophyte produces mycotoxins that cause prolonged gestation, stillborn foals, retained placenta, reduced or absent milk production and difficulty rebreeding. The endophyte does not appear to have adverse effects on non-pregnant mares, geldings, stallions or growing horses.

Tall fescue may be found in pastures in southeast Alberta as well as in the Peace River area. The endophyte can also be present in tall fescue hay.

Pregnant mares grazing endophyte-infected tall fescue should be removed from the pasture 30 to 60 days before foaling and/or treated with the drug Domperidone to counteract the effects of the mycotoxins. You can dilute endophyte-infected hay by feeding other forages along with the infected tall fescue. Newer, endophyte-free varieties of tall fescue are available and should be used if you want tall fescue in your pasture mix. Other varieties of fescue, including creeping red fescue, do not contain the harmful endophyte.

Which Clover Is it?

Figure 22. Red clover.
- Pink to purple flowers
- Hairy leaves and stems
- Upright growth habitat
- Leaves have a watermark (a white "V" on the leaf)

Figure 23. White clover.
- White to pink flowers
- Leaves and stems are not hairy
- Growth of stems is along the ground
- Leaves have a watermark

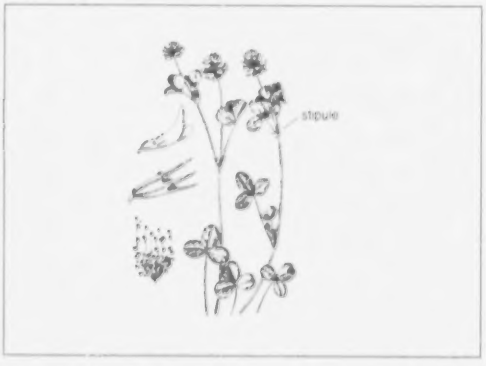


Figure 24. Alsike clover.
- White to pink flowers
- Leaves and stems are not hairy
- Upright growth habitat
- Leaves usually have NO watermark

Drawings courtesy of the United States Department of Agriculture, Natural Resource Conservation Service.

Pasture Can Be a Rich Source of Nutrients

Quality forage, whether it is hay or pasture, should be the foundation of your horse's feeding program. Good quality pasture can provide much of the nutrition a horse needs. Pasture also provides an economical forage. The cost of pasture as a feed is estimated to be nearly one-tenth the cost of hay.

Meeting Your Horse's Nutritional Needs

The ability of pasture to supply the feed requirements of your horse will depend on several factors:

1) **Species growing in the pasture**
   Legumes are higher in protein and digestible energy (calories) and lower in fibre than grasses. Therefore, a pasture with a higher proportion of legumes, such as alfalfa or clover, will possess a higher nutritional value compared to an all-grass pasture.

2) **Plant's stage of maturity**
   Pasture forages are high in nutritional value when actively growing and become lower in nutritional value with maturity. The more immature the plant, the more nutritious and palatable; however, the smaller the plant, the less feed it provides.

3) **Season**
   Spring grass contains the highest levels of protein and lowest levels of fibre of any grass of the year. As the grazing season progresses into summer and fall, a reduction in growth and an increase in maturity of the forage leads to a lower nutritional value.

4) **Horse's physiological state**
   In many cases, good quality pasture can meet the nutritional needs of most adult pleasure horses, along with water, salt and trace mineral supplementation. Even growing two-year-olds can get all they need from good quality pasture. Weanlings, yearlings, pregnant and lactating mares and horses in hard work, however, may be left short by an all-pasture diet. These groups of horses have higher nutritional requirements and would likely require grain feeding (0.5 to 1.0 per cent of body weight) as well as grazing.

Taking representative samples of the forage growing in your pasture at different times of the year and sending them to a laboratory for chemical analyses is the most accurate way to help you determine the overall feeding value of your pasture.

How Much Pasture is Your Horse Eating?

Pasture intake will vary depending on the season, species and quality of pasture grazed, length of grazing time and grazing management.

In addition to what your horse consumes, you must also account for how much forage your horse damages through trampling. One rule of thumb is that a horse will eat, trample or damage 1 pound of forage per pound of body weight per month (or 1 kg forage per 1 kg body weight). Therefore, to sustain an average 1,100 lb (500 kg) horse, a pasture must be capable of producing at least 1,100 lbs (500 kg) of forage each month. With proper grazing management, the amount of forage needed per horse can be reduced by 10 to 20 per cent.

The amount of forage a pasture produces varies by the type of forage growing and the season. Grass and grass-legume pastures produce more forage over the grazing season than pastures consisting of native rangeland species. Growth is most abundant in the spring and early summer, while growth slows in the summer and fall.

In Alberta, approximately 60 per cent of the forage on pastures will be produced by early July. Table 9 shows the average forage production that can be expected with proper management of different types of pasture.

Table 9. Average forage production (per acre) on well managed grass and grass-legume pastures.

Month	Grass Pasture	Grass-Legume Pasture
May	720 lbs (325 kg)	1750 lbs (795 kg)
June	1700 lbs (775 kg)	2600 lbs (1180 kg)
July	1550 lbs (705 kg)	1900 lbs (860 kg)
August	1600 lbs (725 kg)	2000 lbs (910 kg)
September	1030 lbs (470 kg)	2050 lbs (930 kg)
Total over grazing season	6600 lbs (3000 kg)	10,300 lbs (4675 kg)

Source: Modified from grazing research data collected at Lacombe, Alberta (Courtesy of Dr. Vern Baron, Agriculture and Agri-Food Canada)

Grazing with other livestock

Grazing cattle or sheep with horses can keep pastures grazed more uniformly and can help maintain the pasture's forage in the high quality growth stage. Cattle and horses select the same forage species, but horses tend to graze particular areas in the pasture while cattle and sheep graze more at random. Cattle will also graze the more mature forage left by horses, and sheep will utilize more of the forbs and shrubs.

Furthermore, livestock avoid grazing near their own manure, but are willing to graze near piles left by other species. Cattle, sheep and horses do not share the same intestinal parasites, so there is no risk of becoming infected when grazing around each other's droppings. Cattle, sheep and horses may all graze the pasture at the same time, or one group may precede the other.

Preventing Laminitis and Colic

Horses that are allowed to over-eat lush pasture may be at risk for colic or laminitis. Fat horses and ponies are particularly at risk of laminitis, colic and other problems of over-indulgence. But all horses may be at risk if they are not properly adapted to grazing lush pasture. Tips for preventing laminitis and colic on lush pasture:

- **Gradually adjust time on pasture.**

  Start with two hours of grazing and gradually build up to full-time turnout over a period of two or more weeks. Keep in mind, your horse may only need to be on pasture five to six hours per day to meet its nutritional needs on lush, spring pasture.

- **Make sure your horse is well fed before placing it on pasture.**

  Turning a hungry horse out to pasture is just asking for disaster. Instead, feed your horse hay before turning out to graze. It is best to feed in a stall or corral away from the pasture, because giving a choice between lush grass or hay while on pasture is like asking a child to choose vegetables over candy.

- **Observe horses daily when first turned out on pasture.**

  Check for lameness or heat in the hooves, indicative of laminitis, and watch for signs of abdominal discomfort (rolling, kicking or biting flank), which are signs of colic. Call your veterinarian immediately if anything seems amiss.

- **Adjust feed to need.**

  Pasture-related colic and laminitis can largely be avoided by providing only the amount of feed your horse needs. In some cases, you may have to totally eliminate grazing from your horse's feeding program to better control their daily feed intake.

If you have any questions about turning your horse out onto spring grass, consult your veterinarian for a recommendation.

Nitrate Toxicity and Horses

Plants naturally take up nitrogen from the soil in the form of nitrate, which they use to make plant protein. Any time the plant is stressed, such as during a drought or after a frost, plant growth slows. If the plant is not growing, the nitrate is not being turned into protein and is accumulating within the plant tissues instead.

Cows and other ruminants are most sensitive to nitrates. Nitrate levels above 0.5 to 1 per cent in the total diet dry matter are known to cause toxicity in cattle and sheep. Horses digest nitrates somewhat differently than cattle and are therefore thought to be more tolerant of nitrates in their feed. There are reports of growing horses and pregnant and lactating mares receiving 1.8 to 2 per cent nitrate in their hay without any adverse effects. It is recommended that nitrate concentrations should not exceed 1 per cent of the horse's total diet, just to be safe.

Nitrate accumulation is most common in fast-growing annual crops, such as oats and barley. However, nitrates can also accumulate in hay crops and pastures if they were fertilized just before being stressed by drought or frost. Pastures with elevated nitrate levels can safely be used by gradually adapting the animals to pasture and by supplementing grazing with hay.

Equine Grazing Behaviour

Horses are instinctively selective grazers, basing their choice of pasture plants on what tastes good (palatability) as well as availability. Horses prefer to eat young, immature plants and will graze some areas of a pasture down to the bare ground. In other parts of the pasture, plants are avoided and allowed to grow to maturity, which lessens palatability and nutrient availability. In addition, horses will not graze in areas where they defecate, so pasture plants around manure piles are also mature and less palatable. This grazing pattern is often called "spot" grazing.

Horses can also graze much closer to the ground than cows can because horses have upper and lower incisors. However, clipping off the plants too close to the ground can cause problems for plant regrowth.

Close cropping of pasture plants, trampling and selective grazing can seriously affect the productivity of a pasture (Figure 25). Selective grazing of areas with short, new growth over and over again, without giving the plants a reprieve, causes the plants to decline in vigor or persistence. As the desirable species of forage are grazed out or trampled, weeds tend to invade the pasture. Thus, horses can quickly turn a pasture into a weed patch or dry lot.

Although horses are selective in their grazing habits, they can be "persuaded," with proper pasture and grazing management, to eat pasture that they might otherwise choose to avoid. This approach is not being unkind to your horses, it is simply managing their grazing to give them as much pasture as you can for as long as possible.

How Many Horses Will My Pasture Support?

The most common question asked by horse owners is, "How many horses can I keep on my property?" Unfortunately, the answer to this question is not always straightforward, and there is considerable variability. Several factors will determine the number of horses your pasture(s) will support:

Acreage available for grazing
Land available for grazing is what is left over after you exclude areas used for buildings, stables, trees, house, driveways, sloughs, rivers and creeks.

Species of forage growing in the pasture(s)
Horses kept on unimproved, "native" rangeland pastures often require more land to sustain each horse. Improved, "tame" grass and grass-legume pastures will produce more forage than native rangeland, allowing more horses to be supported by a smaller area.

Figure 25. Spot grazing = portions of pasture being overgrazed and other portions of the same pasture being undergrazed. Spot grazing results in the appearance of "lawns" (closely cropped areas) and "roughs" (tall, over-mature plants and manure piles).

Quality of the pasture forage available
The more desirable the forage species growing in your pasture and the more forage available for grazing, the higher the pasture quality. If your pasture is overgrazed, full of weeds and bare spots, you have a poor quality pasture.

Soil and climate characteristics unique to your area of Alberta
Grey wooded soil supports more horses than the brown soil regions. With good rainfall or irrigation, less acreage may be required. During times of drought, the number of horses per pasture should be reduced.

Grazing management employed
How you manage your pastures can be the biggest factor that determines the number of horses your land can support. Proper management will increase the productivity and long-term survival of your pasture. The less land you have, or the more horses you pasture per acre, the more intensive management you will need to provide to maintain your pastures in healthy, useful condition.

Physiological state and size of horses grazing the pasture
Lactating mares with foals require almost twice as much feed as an idle mature gelding. Similarly, bigger horses graze more grass. Therefore, the number of horses your pasture will support should be adjusted based on the size and physiological state of the horses.

Municipal restrictions
Check with your local municipality to see if there are any regulations concerning horsekeeping. Areas may have regulations regarding number of horses allowed, odour, flies, disposal of manure and drainage onto neighboring properties.

Keep in mind, there are limits to a particular property's ability to support animals. Sadly, you may have to face the fact that you just cannot house the number of horses you would like at your current location without causing detrimental effects to the environment.

Calculating Stocking Rates

When determining the number of horses your pasture can support or the amount of land needed to support the grazing of your horses, you are calculating the "stocking rate."

The following equation can be used as a guideline for determining the number of pasture acres required for grazing:

$$\text{Pasture acres required} = \frac{(\#\text{ horses}) \times (\text{average body weight in pounds}) \times (0.035) \times (\#\text{ grazing days})}{\text{Average forage production, in pounds per acre}}$$

For example, say you have two, 1,100-lb horses and you want to graze them for 3 months. You estimate your pasture will produce an average of 2,000-lbs of forage per acre in that 3-month period (refer to Table 9 for average pasture forage production or well managed pastures).

$$\text{Pasture acres required} = \frac{(2) \times (1{,}100\text{ lbs}) \times (0.035) \times (120\text{ days})}{2{,}000\text{ lbs per acre}}$$

$$= 4.6\text{ acres would be needed for 120 days of grazing these 2 horses}$$

Table 10 shows some reasonable estimates for the number of acres needed to support an average 1,100-lb horse for one month of grazing, based on the annual precipitation and the quality of the pasture.

Table 10. Average number of acres needed to support one horse (1,100 lbs or 500 kg) for one month based on the annual precipitation and the quality of the pasture.*

Annual precipitation		Number of acres needed to support one horse for one month		
mm	Inches	Excellent pasture	Good pasture	Poor pasture
250 – 350	10 – 14	1.7	2.5	5.0
350 – 450	14 – 18	1.0	1.5	3.3
450 – 550	18 – 22	0.6	0.9	1.7
550 – 650	22 – 26	0.4	0.6	1.1
Irrigation		0.2	0.3	0.5

* If you have more than one horse, multiply the number of acres per month by the number of horses.
* If you have horses that weigh more or less than 1,100 lbs (500 kg), calculate your horse's proportion to the generic 1,100-lb (500-kg) horse and multiply it times the number of acres per month. For example, if you pastured an 1,300-lb horse on excellent pasture that received 14-18 inches of rain, you would need 1.18 acres (1,300 ÷ 1,100 = 1.18 X 1.0 acre = 1.18 acres). If you pastured a 550-lb (250-kg) weanling on the same type of pasture, you would need 0.5 acres for one month (500 ÷ 1100 = 0.5 X 1.0 acre = 0.5 acres).

Grazing Management

Managing the grazing of your horses will have a greater effect on the productivity of your pasture than almost any other factor, including the species of forage growing there.

Two important practices that need to be implemented into your grazing management plan are **proper timing of grazing** and a **rest-rotation schedule**.

Time to Eat

A simple way to determine if your pasture is ready to graze is to measure the height of the forage (Figure 26). Using a ruler, record the height of the vegetation as it stands naturally (do not stretch or extend leaves) at several locations within the pasture and average the heights. Each 2.5 cm (1 in.) you measure is equivalent to approximately 100 to 250 kg (200 to 500 lbs) of forage.

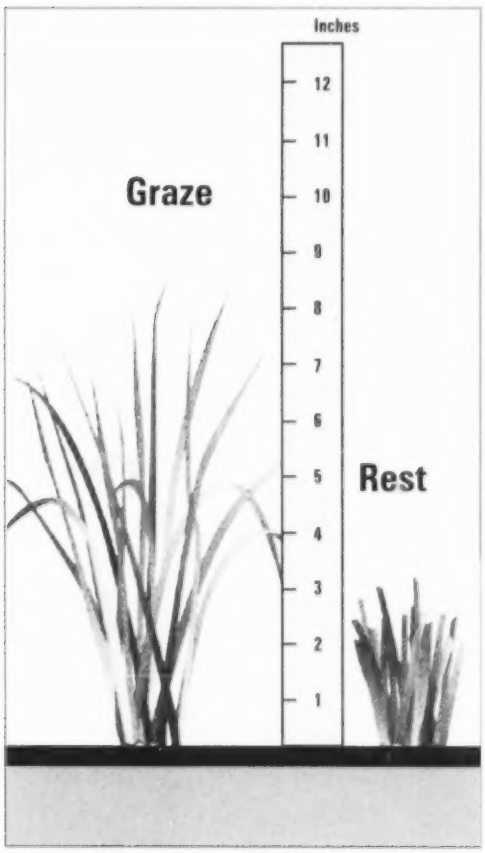


Figure 26. A pasture should contain at least 15-20 cm (6-8 in.) of growth before grazing is allowed. Horses should be removed from a pasture when plants are grazed down to 8-10 cm (3-4 in.).

A pasture should contain at least 15 to 20 cm (6 to 8 in.) of growth before horses are allowed to graze. This rule for grazing height holds true whether you are just turning your horses out in the spring, or you are returning them to a field that was allowed to regrow after a period of rest.

Grasses and legumes need time for sufficient growth before grazing is allowed. If grazed too early, plants may die and be replaced by undesirable plants species and weeds.

A Little R'n R

Knowing when to *stop* grazing is just as critical to maintaining a productive pasture as deciding when to begin grazing. Pastures must have a periodic rest from grazing, so they can recuperate.

Once horses have grazed the majority of the grass in a pasture down to 8 to 10 cm (3 to 4 in.), remove the horses from the pasture. Never allow grass to be grazed shorter than 8 cm (3 in.). This practice ensures that the grass will have enough food reserves to permit rapid regrowth. You can put horses back on pasture when the grass has regrown to about 15 to 20 cm (6 to 8 in.).

Regrowth of pasture plants usually takes two to six weeks, depending on the time of year. In the spring, forages grow twice as fast as they do during the summer, so pasture rest periods may be shorter in the spring and longer in the summer and fall.

Rotating horses through a series of pastures (termed "rotational grazing") or removing horses from pastures for part of the day (known as "limited grazing") are practices that will provide rest periods.

The key to maintaining a productive pasture is to manage your horses so that grazing removes only a certain amount of the plant and leaf area, leaving enough behind for the plant to recover and begin regrowing again.

Grazing Systems

Several grazing schemes can be used to control your horse's grazing and, at the same time, to promote healthy pastures. Keep in mind that no one grazing scheme is best for all situations, and a combination of techniques may work best for you.

Rotational Grazing

The concept behind rotational grazing is to break up larger pastures into smaller sections, so you can control your horse's grazing in a smaller area. This practice encourages the horses to be less selective and to graze the available forage more evenly. Once one section is grazed down, the animals are moved to a new section while the grazed section is allowed to rest and recover from grazing and hoof damage.

As a first step towards a rotational grazing system, you may want to first try dividing an existing large pasture in half and then alternate grazing. Then, try further subdividing the pasture after you gain some experience (Figure 27).

Ideally, you want at least four smaller pastures that provide enough grazing for seven to ten days.This grazing duration gives each pasture a rest of three to five weeks. As the grass matures and growth slows during the summer, you will likely have to decrease grazing time and increase resting time.

The movement of horses should be based on the growth rate of the pasture and the specific height of the forage, not on the calendar. Begin grazing when the forage is 15 to 20 cm (6 to 8 in.) tall. Once horses have grazed a pasture down to 8 to 10 cm (3 to 4 in.) rotate them onto the next pasture.

In spring and early summer, when growth is fast, you may find that your horses cannot keep pace with the rapidly growing grass in your pastures. While you could wait for your horses to graze one pasture down to 8 to 10 cm (3 to 4 in.), the forage in your other pastures would mature and quickly become less palatable. Instead of waiting, you might choose to move your horses to other sections sooner, so they have a chance to graze the tops of all pastures. Alternatively, you might be able to harvest hay from one or more pastures that cannot be effectively grazed in the spring and early summer.

If the size of your available acreage is small, you may find that your first pasture has not yet recovered to grazing height by the time you have rotated through all the other pastures. To avoid overgrazing, supplemental feeding and/or reduced or restricted grazing time may have to be used to give each pasture adequate rest.

There may be several options for dividing your pasture into smaller plots for rotational grazing. Remember that all sections must allow access to water. Also, try to divide pastures in such a way that horses can have access to shade or shelter, especially if they will be confined to these areas for more than a few hours (Figure 27).

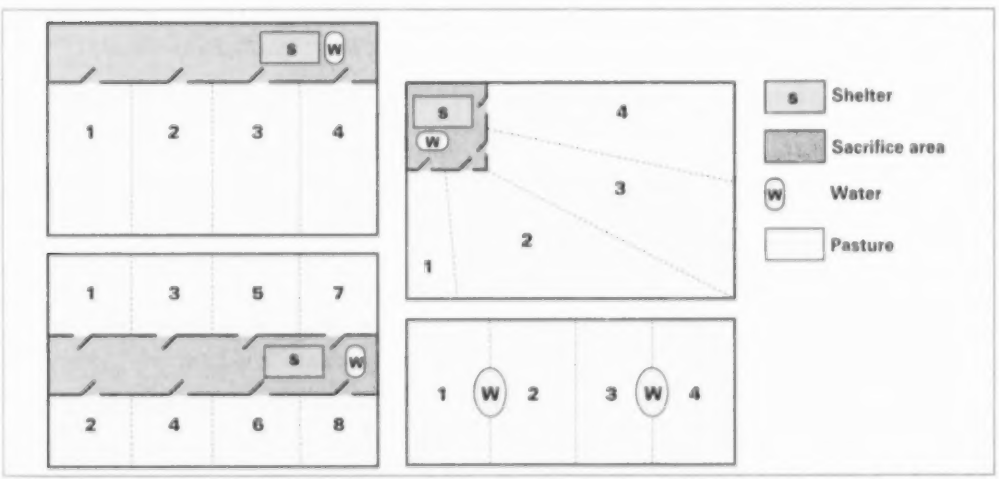


Figure 27. Options for dividing your pasture to facilitate rotational grazing.

Grazing pressure valve

If pasture forage is in short supply, either because of limited acreage, seasonal slumps in pasture growth or too many horses, you can decrease the pressure on your pastures by:

- **Decreasing the stocking rate by removing some or all of the horses from the pasture**
- **Leaving the horses on pasture for only a few hours daily, rather than all day**
- **Feeding hay for at least four hours before turning horses out on pasture**

Fence me in

Portable electric fencing or tape is a simple and inexpensive way to create temporary paddocks in a large pasture to facilitate rotational grazing. And when it is time to rotate the horses into a new area, the electric barriers are easy to move. If you use only one tape or strand, then string it at a height of approximately 84 cm (33 in.); hang double strands at 50 and 90 cm (20 and 36 in.); space triple strands at 40, 70 and 100 cm (16, 28 and 40 in.). Easy-to-install electric fencing systems can be purchased from most farm supply stores.

Advantages of Rotational Grazing

- Increases the amount and quality of forage obtained by grazing
- More animals can be supported on the same acreage of pasture
- Reduces or eliminates selective or spot grazing
- Allows for more complete utilization of pasture forage
- Minimizes "rejection areas" where horses will not graze
- Promotes the growth of desired species and reduces the number of undesirable species and weeds.
- Can help control parasites and discourage some animal diseases
- May permit harvesting of excess forage in spring and stockpiling forage for the fall
- Provides better manure distribution and nutrient recycling
- Allows for frequent horse-human contact

Practice Limit Grazing

The more horses you have on your property, and the less land you have, the more challenging it can be to manage your pastures. You can still preserve your pastures and keep them healthy by limiting the amount of time your horses graze. Although more hand-feeding will be required, pasture turnout can still contribute to your horse's health.

There are many ways to modify a limited grazing routine to fit your horses, farm and schedule. You might choose to turn your horses out once or twice a day, before or after work, for a few hours each time. Night turnout is appealing to some owners because the absence of the sun prevents bleaching of the haircoat. There are also fewer bugs at night. If you have several horses, you could turn one group out at night and a separate group out during the day, so the ground suffers less abuse at one time.

Always remember to monitor the height of the grass. As the vegetation is grazed down to 8 to 10 cm (3 to 4 in.), remove your horses and place them into a corral or dry lot area (see the information on "Sacrifice areas" below). Wait until the forage has regrown to a height of 15 to 20 cm (6 – 8 in.) before allowing your horses access to pasture again.

Continuous Grazing

Many horse owners allow their horse access to a pasture continuously. The horse usually remains on the same piece of land over the whole grazing season. This type of grazing system is called "continuous grazing."

Although continuous grazing requires the least amount of capital investment and management, this type of system can be very unhealthy for the land. Unrestricted access allows horses to be highly selective during much of the grazing season, creating both overgrazed forage and areas of under-used and wasted forage. A loss of desirable forage species, invasion of weeds, erosion and the nonuniform distribution of horse manure are other problems commonly associated with continuously grazed pastures.

To maintain a healthy plant stand with continuous grazing, you will need a sufficiently large land area and you need to maintain a low stocking rate.

A Small Sacrifice

You can greatly improve the health and productivity of your pastures by creating and using a "sacrifice area." A sacrifice area is a small enclosure such as a paddock, corral or pen, or turnout area. The concept is that a selected area is sacrificed from the grazing system and is used to confine the horses to protect pastures from over-use at critical times.

Sacrifice areas give flexibility to the management of your horse property. Horses can be confined to the sacrifice area when:

- pastures need a rest from grazing
- you want to control the amount of grass your horse consumes on a daily basis
- you want to prevent over-consumption of lush pasture in the spring and early summer
- you need to care for sick or injured animals

Sacrifice areas also have other benefits. They can serve as a central watering location for rotational grazing systems, and they provide a location for supplemental feeding. Sacrifice areas are also ideal for helping to juggle the turnout of compatible groups of horses when pasture area is limited. In addition, manure

deposits are confined to a smaller area, which can be cleaned and the manure removed more frequently.

When choosing a location for a sacrifice area, select a site on higher, drier ground, away from wetlands, streams or ditches. Surround the area with at least 8 to 15 m (25 to 50 ft.) of lawn, pasture, trees or bushes. This vegetative buffer will act as a natural filter for contaminated water running off the area.

For chore efficiency, you may want to keep the area close to the barn. You may have several turnout paddocks that you rotate stalled horses through during the day. Alternatively, you could set up a sacrifice area for each horse as a run off of each stall.

The amount of land you have available and the number of horses and their temperaments will all affect the size of the sacrifice areas you need. Approximately 100 square meters (1,000 ft^2) will be needed for each horse. The shape of a sacrifice area can be square or it can be a long, narrow enclosure that allows horses to run and play. Approximately 6 to 9 m (20 to 30 ft.) wide by 30 m (100 ft.) in length will allow a horse to trot; 60 m (200 ft.) in length will allow a horse to canter.

Footing for the horses is an important consideration for sacrifice areas. The objective is to have a hard-wearing, steady surface that is able to cope with plentiful hoof traffic without degenerating into dust and mud. Hogfuel or woodchips may help eliminate the urine smell often present in outdoor confinement areas. Crushed rock (no larger than 5/8 in.) or sand will also work well in some situations.

The area should slope 2 to 4 per cent to avoid ponding of water and to reduce erosion. Roof runoff from barns and other structures should be drained away from the sacrifice area.

Home on the Range

Many horses in Alberta may be grazing rangeland rather than cultivated pastures. The native vegetation in a rangeland ecosystem may involve hundreds of species that have evolved and adapted to the local soil and climate conditions over thousands of years.

Growth of native rangeland species typically follows rainfall. Because of this characteristic, most of the rangeland growth occurs in early summer, with very little occurring thereafter unless it rains (see Table 11).

Because the majority of growth occurs at one time, maintaining horses on native rangeland can be quite a challenge. Rangeland can easily be overgrazed unless forage production is matched with grazing pressure.

Tips for managing the grazing of horses on native rangeland:

1) **Practice rotational grazing**
   Concentrate your horses' grazing in a smaller area when growth is abundant in the spring and early summer, and allow other areas to remain unused. In essence, you are stockpiling or saving the forage. When the horses have grazed the first area down, rotate them into a new area where the forage has been stockpiled.

All you can eat?

A horse turned out to pasture full time will generally graze 14 to 16 hours during each 24-hour period. If the pasture is of good quality, mature horses may become overweight with this much grazing time. Particularly in the spring, this technique would be like allowing your horse to munch on oats all day long.

If your pasture contains adequate quantities of good quality pasture forage, your horse may be able to consume a sufficient quantity to meet their nutritional needs in five to six hours daily. Of course, if your pasture is overgrazed with sparse forage, you will have to increase the amount of time your horse is allowed to graze accordingly.

Table 11. Average forage production (per acre) of rangeland pastures.

Month	Mixed Prairie	Fescue Prairie	Aspen Parkland
May	450 lbs (205 kg)	200 lbs (90 kg)	200 lbs (90 kg)
June	100 lbs (45 kg)	950 lbs (431 kg)	350 lbs (160 kg)
July	0 lbs (0 kg)	50 lbs (22 kg)	0 lbs (0 kg)
August	0 lbs (0 kg)	0 lbs (0 kg)	0 lbs (0 kg)
September	0 lbs (0 kg)	25 lbs (12 kg)	0 lbs (0 kg)
Total over grazing season	550 lbs (250 kg)	1225 lbs (555 kg)	550 lbs (250 kg)

Source: Modified from *Range Pasture: in Alberta* (1988), Alberta Agriculture, Food and Rural Development

2) **Confine horses to a sacrifice area during critical times**
Regrowth of grazed rangeland may be slower than in cultivated pastures. As a result, there may not be sufficient regrowth in previously grazed pastures for you to be able to safely turn your horses back out without hurting the native grasses. Confining your horses to a corral or dry-lot (sacrifice area) will require you to hand-feed, but it will spare your rangeland pastures from damage that could be irreversible.

3) **Inter-seed rangeland with higher producing grasses and legumes**
The overall production of forage can be improved on native rangeland by introducing a compatible grass or legume.

Extending the Grazing Season

The grazing season in Alberta typically begins in mid to late May and carries into mid to late September. However, there are a few things that can be done to encourage plant growth earlier in the season or to extend grazing into the late fall.

- Proper fertilization in the spring may allow grazing to begin one or two weeks earlier in the season.
- Practice rotational grazing to keep forage in the vegetative growth stage.
- Stockpile forages to use in October and November by allowing a pasture to grow ungrazed starting in July (creeping red fescue is especially good for stockpiling).
- Seed a legume to provide forage during the hotter summer months when grasses go dormant.
- Plant specialty or annual crops, such as oats or fall rye, that will provide grazing in July and August.

Routine Pasture Management

Design and Layout

A good pasture contains a clean, reliable water source, mineral salt blocks and shelter from the sun and inclement weather. Careful arrangement of fences to provide for easy access to water, mineral, salt and shelter should be part of all pasture programs.

If you own portable fencing, water troughs and feed bunks, your pasture layout can be changed to better serve your needs throughout the year. You can design your pastures to manage for high rainfall years or drought. You can also move your fencing to change your horses use of their pasture, which will protect more susceptible areas from regular hoof traffic.

Soil Testing and Fertilizing

The quantity and quality of the forage produced by your pastures can usually be greatly increased by proper fertilization. In addition, application of the correct amount of fertilizer can decrease weed problems by making your grass plants so vigorous that weeds cannot get established.

To determine the amount of fertilizer your pastures need, you must first have your soils tested. Soil testing reveals the existing nutrient levels in the soil, as well as the nature and condition of the soil, all of which can be corrected to improve pasture production. For more information on soil testing, refer to "Step 1: Sample Your Soil" in the chapter "Managing Manure by Spreading on Cropland and Pasture."

Once you have found out from your soil test what nutrients your pastures need, apply only those nutrients in the amounts recommended. Over-fertilizing is not only costly, but may also contribute to surface water pollution.

Commercial fertilizer mixtures typically supply combinations of nutrients in various proportions, the most common ones being nitrogen, phosphorus and potassium. These mixtures should only be used if ALL the nutrients they contain are lacking in the pasture. A better alternative would be to have a custom fertilizer mix created for your pastures based on the recommendations made in your soil analysis.

Be aware that the type of plant species growing in your pasture may affect which nutrients are needed for better production. Grasses benefit from nitrogen fertilization, whereas legumes respond better to phosphorus, potash and lime. A pasture containing a mix of grasses and legumes may not need nitrogen fertilization if the pasture contains at least 40 per cent legumes. In fact, untimely or excessive nitrogen fertilization of a grass-legume pasture may be detrimental because grasses might crowd out the legumes.

Exercise paddocks

If your acreage is too small to support the menu of your horses, you can still develop a grassy exercise paddock where your horses can have some free time.

- **Plant sod-forming grasses that are more resistant to close grazing and trampling (creeping red fescue and smooth brome grass)**
- **Limit turnout time to help preserve good ground cover**
- **Remove manure or drag the paddock regularly**
- **Mow undergrazed forage**
- **If the paddock appears overused, give it some well-needed rest**

The timing of fertilizer application is just as important as the type and amount applied. Applying fertilizer several times throughout the grazing season is more beneficial than a single annual application. For example, a portion of the yearly nitrogen application can be applied in the spring to encourage initial spring growth, and another application can occur in the late summer to extend the grazing season and strengthen roots for winter.

Additional applications of nitrogen can be made throughout the growing season. If you practice rotational grazing, a good time to apply nitrogen is just after you rotate your horses off the pasture. Most importantly, fertilizers should be applied only during the growing season when plants can utilize the nutrients.

Horses should be taken off the field when fertilizer is applied. Read the fertilizer product label to determine when it is safe to return horses to the pasture. If you have questions or concerns, consult with your veterinarian.

To monitor the effectiveness of your fertilizer program, you should perform new soil tests on your pastures every two to three years.

Information on the fertilizer requirements of different crops can be found on Alberta Agriculture's website (www.agric.gov.ab.ca) or in the Alberta Agriculture publications *Alberta Fertilizer Guide* (Agdex FS541-1) and *Crop Nutrition and Fertilizer Requirements* (Agdex FS 540-1). For information on using manure as a fertilizer for your pastures, see the chapter "Managing Manure by Spreading on Cropland and Pastures."

Weed Prevention and Control

Weeds are undesirable plants that have either limited or no grazing value. Common weeds such as Canada thistle are invasive and reduce pasture production.

Weeds thrive in overgrazed and abused pastures, competing with desirable plants for sunlight, moisture and nutrients, and often winning. Weeds severely reduce the feed value of your pasture, and at their worst, some weeds are even harmful to your horses (see the section "Hazardous Materials").

The techniques for getting rid of existing weeds in your pasture include removal by hand, mowing and herbicide application. Weed removal should be done before perennial weeds bud and before annual weeds seed.

If you choose to apply herbicides, make sure the product you are using is effective for the specific weed you are trying to control and that you apply it at the correct time or stage of growth. Only spray areas with weeds and be aware of wind drift.

Horses should be removed from herbicide-treated pastures. Not only may the chemicals be harmful to horses, some herbicides make poisonous plants more attractive or palatable. The length of time horses will have to be held off pasture depends on the product used. Always read and follow all instructions and precautions on the product label.

Herbicide application may correct your current weed problem. However, if you do not change your management style to prevent weeds from becoming established, they will come back. Weeds often get started in handling areas, fence lines, watering sites or winter feeding areas. Monitoring these sites on a regular basis is the best method for early detection of weed problems.

Tips for Weed Prevention:

- Promote healthy growth of desirable pasture plants with a proper fertilization program
- Do not overgraze your pastures
- Buy certified weed-seed-free hay
- Mow pastures regularly before weeds go to seed or before they shade out developing grasses
- Early identification of undesirable weeds and poisonous plants

For more information on weed identification and eradication, see the Alberta Agriculture publications, *Weeds of the Prairies* (Agdex 640-4) and *Crop Protection* (Agdex 606-1). For more information on poisonous plants, refer to *Poisonous Plants on Rangeland and Pasture* (Agdex 130/666-1).

Drought management tips:

- **Reduce the stocking rate of your pastures**
- **Give pastures longer rest periods**
- **Confine horses off of pasture**
- **Control weeds**
- **Be aware of poisonous plants—lack of available forage may cause your horse to eat them.**

Hazardous Material

Because horses are very selective grazers, they are extremely good at avoiding poisonous plants — as long as they have a choice. When pastures are overgrazed and horses are hungry or bored, they are more likely to try a plant that could be harmful. Some of the poisonous plants found in Alberta are listed below. If you identify a potentially harmful species of plant in your pasture, it should be removed. Contact your veterinarian if you suspect poisoning.

Potential Poisonous Plants

Arrowgrass (*Triglochin maritima*)

Chokecherry (*Prunus* spp.)

Death camas (*Zgadenus* spp.)

Dogbane (*Agocynum* spp.)

Early yellow locoweed (*Ocytropis macounii*)

Horsetails or scouring rush (*Equisetum* spp.)

Lady's-thumb (*Polygonum* spp.)

Low Larkspur (*Delphinium bicolor*)

Tall Larkspur (*Delphinium glaucum*)

Lupines (*Lupinus* spp.)

Milk-vetch (*Astragalus* spp.)

Monkshood (*Aconitum* spp.)

Mustards (*Brassica* spp.)

Saskatoon berry (*Amelanchier alnifolia*)

Showy milkweed (*Asclepias* spp.)

Western water hemlock (*Cicuta douglasii*)

Mowing

Horses are selective grazers, eating some plants close to the ground and leaving others untouched. Plants also grow rapidly around manure piles, as a result of the added fertility of the manure and because horses avoid grazing near these spots, so you will want to mow.

Mowing can increase the quantity and quality of grazing. Mowing your pastures cuts all the plants to the same height, stimulating more uniform regrowth and preventing grass plants from getting too tall and tough to be appetizing to horses. Cutting down weeds before they have a chance to go to seed is also a very important weed management technique.

Set your mower deck to a height of 10 to 15 cm (4 to 6 in.). Ideally, pastures should be clipped before grass seed heads emerge ("heading") to encourage plants to produce leafy, higher quality vegetation. If you use rotational grazing, clip your pastures immediately after you remove your horses from the grazed area.

Harrowing

Pastures will also benefit from harrowing the manure. Dragging the pasture spreads manure evenly over the grazing area, thereby recycling the nutrients back into the soil more effectively.

Harrowing can be done when it is hot or cold, but it should be performed in dry weather. Harrowing at this time breaks up the manure clumps, so they can dry out and kill intestinal parasite eggs and larvae. In contrast, spreading

manure in warm, moist weather encourages parasite eggs to hatch and thrive, increasing the risk of reinfecting your horse. After scattering the manure piles, do not let the horses graze the area for three to four weeks.

Harrowing can easily be incorporated into a pasture rest-rotation schedule. Immediately after an area has been grazed and the horses have been removed, mow the area and harrow while the grass is short and the manure is still fresh.

Equipment Checklist

The equipment you use to keep your pastures healthy does not have to be complex or expensive—it all depends on the size of your place and your needs.

- Lawnmower—riding lawnmowers (16 to 18 horsepower) are effective for small farms and can be used to pull harrows and manure spreaders; a tractor and rotary mower may be necessary for larger pastures.
- Harrow—harrows are used for spreading out manure piles in pastures and can also be used to smooth arena surfaces. You can buy a harrow or make one with a piece of chain-link fencing, an old metal bedspring or gate.
- Manure spreaders—a manure spreader can make the job of spreading your manure or compost throughout your pastures a lot easier. Choose a manure spreader that your riding lawnmower or truck can handle and that it is not too big to maneuver around your pastures. Make sure the spreader is adapted to horse manure. Cow manure is softer and breaks apart more easily, which makes a difference in how the tines in the spreader are structured.
- Electric or portable fence—use fencing to divide your pastures into smaller areas for rotation.

Breaking the Worm Cycle

All horses carry some level of intestinal parasite burden. Considering that 99 per cent of a given worm population exists on pastures, it is not hard to see why proper pasture management is important.

Here are some tips for reducing the risk of reinfecting your horses on pasture:

- Have your veterinarian perform regular fecal egg counts on your pastures
- Establish and maintain a routine deworming program
- Remove horses from pastures after harrowing until manure is dried and partially decayed (approximately three to four weeks in the summer)
- Practice rotational grazing, giving pasture time to rest and manure time to break down
- Remove manure from pastures
- Graze cattle or sheep after horses to break the horse worm cycle (these livestock can ingest horse worm larvae without harm)

Rejuvenating Poor Quality Pastures

Many people have existing pastures that are in need of some help. A loss of desired pasture species, an invasion of weeds or bare spots indicate your pasture is hurting. Plowing up a pasture and replanting can be very expensive and time consuming. Fortunately, large gains in production can be made in a poor quality pasture by applying the same management tools you would use on a healthy pasture.

Pastures can often be rejuvenated simply by applying the appropriate fertilizer. In addition to stimulating the growth of existing plants, fertilizer will stimulate dormant seed that is already in the ground. Have your soil tested to determine the proper fertilizer treatment.

A sound grazing system will also promote a healthy pasture by preventing overgrazing. Pasture grasses and legumes need time to rest and recuperate after they are grazed, so they can build up their own reserves. Monitor grass

Pasture makeover tips:

- **Start an appropriate fertilization program**
- **Manage the grazing of your horses to avoid overgrazing**
- **Mow mature, undergrazed forage**
- **Control weeds before they get to be a problem**
- **Interseed with a legume**

height and remove your horses when the grass is grazed down to 8 to 10 cm (3 to 4 in.). Mow the uneven growth, harrow the manure and let the pasture rest until it has grown back up to 15 to 20 cm (6 to 8 in.) before allowing your horses back out to graze.

Weeds are the biggest culprits in decreasing pasture quality. They steal nutrients from desirable pasture species, and some are harmful to your horses. Weeds should be removed, either physically or chemically. Proper fertilization, grazing management, mowing and early identification will help you combat future weed problems.

Introducing a legume is also a good technique for reviving a horse pasture. Legumes, such as alfalfa, reduce the need for nitrogen fertilization, improve horse performance and provide better seasonal distribution of forage in mid-summer. Legumes can also be added to your existing pasture with plowing it up by interseeding.

There are two methods for seeding legumes into grass sod: frost seeding and no-till drill. Frost seeding is best performed in the early spring. Legume seed is broadcast on the soil and allowed to roll into tiny cracks formed by the natural freeze-and-thaw cycle of this season. No-till drill is performed in the late summer/ early fall. Using this method, a tractor-pulled seeder is used to cut slits in the soil, deposit seed and then roll the slits closed in one operation with minimal disturbance to existing vegetation.

The drawback to any type of seeding is that grazing cannot occur until new plants are established, which can take up to six months. With frost seeding in the spring, that means horses cannot be turned out on the pasture until late summer. With no-till drill in the fall, horses should be able to begin grazing by spring. Where this practice is often not available, horses may be allowed to graze lightly when the new grass is 15 to 20 cm (6-8 in.) in height, but the effectiveness of the interseeding may be lessened.

Because interseeding might put your pasture out of commission for part or all of the normal grazing season, you may want to subdivide your pasture into at least two parts and improve it section by section. This approach keeps some turnout available and distributes expense over time. If only a small area of the pasture will be interseeded, you may be able to fence off the renewed areas and continue to use the remainder of the field.

Using the interseeding option to renovate your pastures is very costly and not always successful. If you decide to attempt interseeding you might want to select a small area as a test site. That way, you will be able to see how successful the technique is on your pasture with little loss of land, time and money.

Remember that once your pasture has been improved, you must continue to actively manage it, so it will remain a good pasture.

A Complete Pasture Overhaul

You may be in a situation where your current pasture is so far gone that you need to start over. Alternatively, you might have just moved to a new property and want to establish new pastures for your horses. It may also be necessary to seed a new pasture if you are converting a row crop field to pasture or where pasture sod does not exist for some reason.

A complete overhaul of an existing pasture should be a last resort. Pasture renovation can be very expensive, and the pasture may be off limits for a year or more while the new growth becomes established. If you have an existing pasture, consider all your pasture improvement alternatives to revive and support the vegetation already growing before settling on a costly seeding effort (refer to the section "Rejuvenating Poor Quality Pastures"). If less than 25 per cent of your pasture growth is desirable plants, opting for complete renovation makes sense.

Several factors are of vital importance in establishing a good horse pasture:

- Preparation of an adequate seedbed
- Matching plant species to your soil and climate
- Selection of high quality seed of an adequate variety
- Using proven seeding methods
- Supplying proper fertility
- Control of pests and weeds
- Keeping horses off the pasture until forage plants are well-established (one to three years)

Unless you have some crop growing experience, you are wise to involve some knowledgeable advisors and/or custom planters in a major pasture renovation or establishment process.

Information on forage species selection, seeding rates and seedbed preparation can be found in the Alberta Agriculture publication *Alberta Forage Manual* (Agdex 120/20-4).

The Bottom Line

- A productive pasture will decrease your feed costs, enhance your horse's health and attitude, and improve the aesthetics of your property.
- Do not begin grazing until pasture vegetation averages 15 to 20 cm (6 to 8 in.) in height.
- Avoid overgrazing by removing horses when vegetation averages 8 to 10 cm (3 to 4 in.).
- Manage grazing more effectively by incorporating a rotational grazing system or limited grazing plan.
- Mow, harrow and fertilize when appropriate to keep your pasture productive.
- Give pastures adequate rest from grazing.
- Create a sacrifice area to conveniently keep horses off pastures when necessary.
- Keep a realistic stocking rate for your property.
- Take good care of your pasture, and it will take good care of your horse.

References and Further Reading

Alberta Agriculture, Food and Rural Development Publications:

Publication:	Agdex #
Alberta Forage Manual (1992)	120/20-4
Establishing Hay and Pasture Crops (1994)	120/22-2
Varieties of Perennial Hay and Pasture Crops for Alberta (produced annually)	120/32
Range and Pasture Management When Dealing with Drought (1989)	130/14-1
Grazing Tame Pastures Effectively (1998)	130/53-1
Native Range Fertilizer Guide (2000)	130/541
Poisonous Plants on Range and Pasture (1991)	130/666-1
Winter Cereals for Pasture (1993)	133/20-1
Alberta Range Plants and Their Classification (2000)	134/06
Cattle Wintering Sites: Managing for Good Stewardship (2001)	420/580-2
Horse Handling Facilities (1997)	460/722-1
Crop Nutrition and Fertilizer Requirements (1998)	540-1
Alberta Fertilizer Guide (1995)	541-1
Tips and References for Owners of Small Farms and Acreages (1998)	570-8
Manure Management to Protect Water Quality (2000)	576-6
Getting to Know Your Local Watershed (2002)	576-8
Crop Protection (the "Blue Book" – produced annually)	606-1
Weeds of the Prairies (2000)	640-4

To order both free and priced Alberta Agriculture, Food and Rural Development publications, call the toll-free line at 1-800-292-5697.

Other Resources

- Environmental Guidelines For Horse Owners In British Columbia. 1995. British Columbia Ministry of Agriculture, Fisheries and Food.
- Pasture Management Guide For Livestock Producers. 1998. Iowa State University Cooperative Extension.
- Manure and Pasture Management for Recreational Horse Owners. 2000. University of Minnesota Extension Service.
- Advanced Forage Management. 1999. Pacific Field Corn Association, Agassiz, BC.
- Pasture for Horses. 1997. University of Wisconsin Cooperative Extension.
- Horses: Manure Management. 1994. Clemson University Cooperative Extension.
- Horse Manure: A Renewable Resource. 1996. Colorado State University Cooperative Extension.
- Caring For the Green Zone, Riparian Areas and Grazing Management. 2nd Edition. 1998. Alberta Cows and Fish Program.
- Healthy Horses, Clean Water: A Guide to Environmentally Friendly Horsekeeping. 2001. Horses for Clean Water, Maple Valley, WA.